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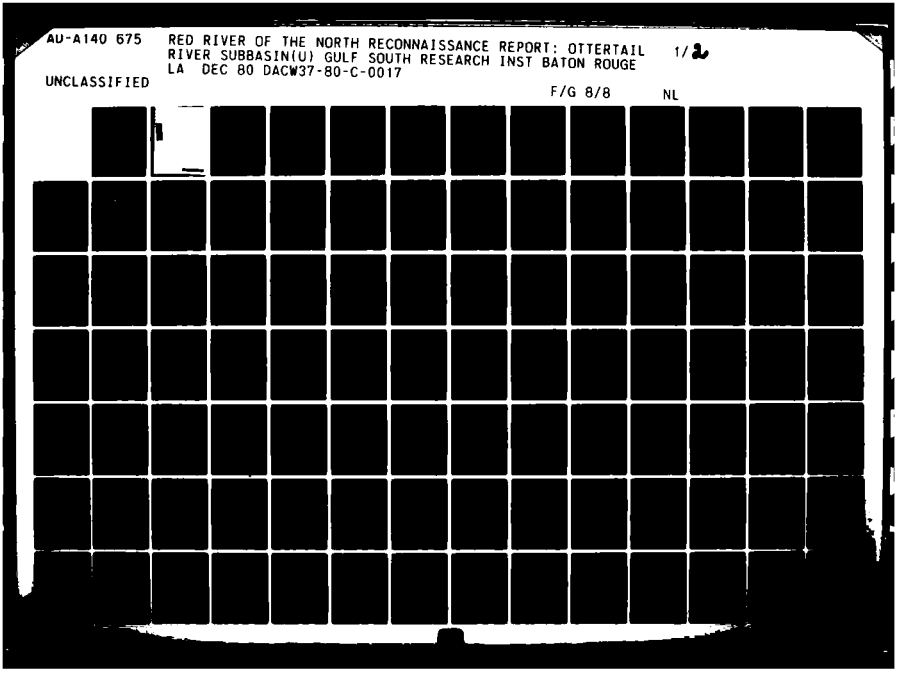

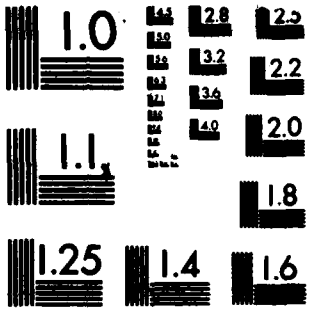

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.
The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and

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problems, to determine priorities for immediate and longrange action, and to identify the capabilities of various governmental units for implementing the actions.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

The Ottertail River Subbasin in southern Minnesota is one of the larger subbasins. Most of the subbasin is located in Ottertail County. A small, but agriculturally important area constitute by the flat plain of the Red River Valley lies in Wilkin County. The upper portion of the subbasin falls into Becker County, and very small portions fall into Clay, Mahnomen, and Clearwater counties. Most of the Ottertail River Subbasin is covered with rolling hills and numerous lakes and depressions interspersed with cropland, pastureland, and forest, which makes this one of the richest of the subbasins with respect to environmental resources.

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RECONNAISSANCE REPORT: RED RIVER OF THE NORTH BASIN, OTTERTAIL RIVER SUBBASIN

Prepared for:

U.S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North Study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.

The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and problems, to determine priorities for immediate and long-range action, and to identify the capabilities of various governmental units for implementing the actions.

The Ottertail River Subbasin is a water resource planning unit located in the southern Minnesota portion of the Red River Basin. This report describes the social, economic, and environmental resources of the subbasin, identifies the water-related problems, needs, and desires, and suggests measures for meeting the needs, particularly in the area of flood control.

The report was prepared almost entirely on the basis of secondary information. However, some telephone contacts were made to verify information and to acquire a more complete picture of local conditions. The only comprehensive report available on the subbasin is a 1947 appendix to the Red River of the North basin survey report, which was published by the St. Paul District Corps of Engineers. Other published sources on the subbasin include:

1. Definite Project Report, Orwell Reservoir, Otter Tail River, which was published by the St. Paul District Corps of Engineers in 1951 and is concerned with the immediate project area.
2. Brief Master Plan for Reservoir Management, Orwell Reservoir, Otter Tail River, Minnesota, which was published by the St. Paul District Corps of Engineers in 1953 and is concerned with the immediate project area.
3. Overall Plan, Cormorant Lakes Watershed District, which was published by the District in 1967 through the Minnesota Water Resources Board and is concerned only with the Cormorant Lakes area, which is in the northwest portion of the subbasin.

In addition, the subbasin received partial coverage in the Souris-Red-Rainy River Basins Comprehensive Study, which was published by the Souris-Red-Rainy River Basins Commission in 1972, and in the Red River of the North Basin Plan of Study, which was published by the St. Paul District Corps of Engineers in 1977.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan. The main report will consider the possibility of various water resource-oriented agencies serving as vehicles for implementing flood damage reduction actions and undertaking additional study needs.

II. DESCRIPTION OF STUDY AREA

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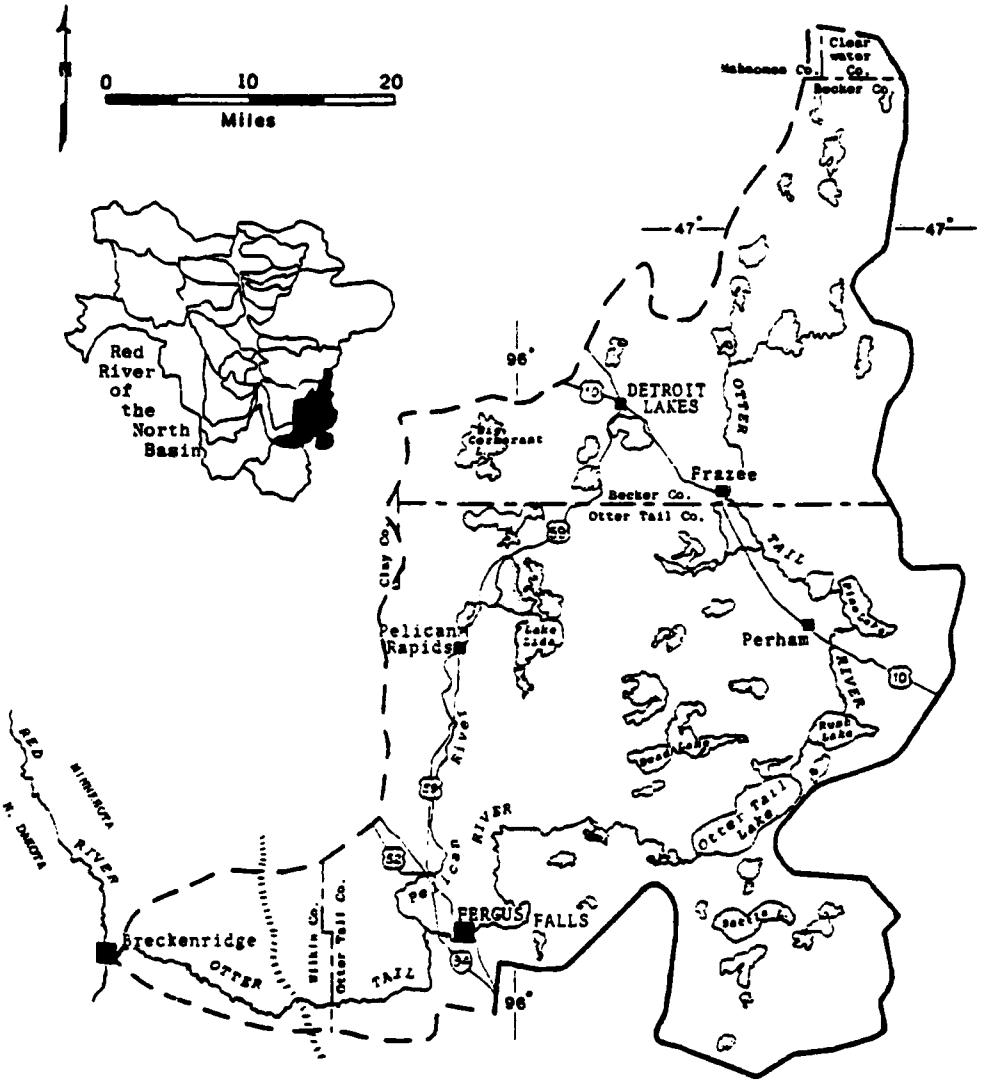
The Ottertail River Subbasin in southern Minnesota has a maximum length of approximately 90 miles and a maximum width of about 30 miles (Figure I). Occupying 1,920 square miles, it is one of the larger subbasins. Most of the subbasin is located in Ottertail County. A small, but agriculturally important area constituted by the flat plain of the Red River Valley lies in Wilkin County. The upper portion of the subbasin falls into Becker County, and very small portions fall into Clay, Mahnomen, and Clearwater counties. A small watershed district has been formed for the Cormorant Lakes area, but the subbasin itself does not have any legal status.

The Ottertail River Subbasin is bordered on the south by the Bois de Sioux-Mustinka River Subbasin, on the west by the Buffalo and Main Stem subbasins, and on the north by the Wild Rice-Marsh River Subbasin. The eastern border is the limit of the Red River Basin study area. The total drainage area of the subbasin is about 1,228,800 acres. However, in the extreme southwest portion, which is very flat, it is difficult to distinguish between the drainage areas of the Ottertail River Subbasin on the one hand and the Bois de Sioux-Mustinka River and Main Stem subbasins on the other.

Most of the Ottertail River Subbasin is covered with rolling hills and numerous lakes and depressions interspersed with cropland, pastureland, and forest, which makes this one of the richest of the subbasins with respect to environmental resources. The northeast point of the subbasin reaches into the Tamarac National Wildlife Refuge and the White Earth Indian Reservation. The extreme southwest portion is the flat plain of the Red River Valley, which is nearly devoid of natural vegetation. Between the rolling hills and flat plain is a transition zone composed of a series of ridges with moderate slopes that are former beach ridges of glacial Lake Agassiz.

The elevation of the lower area varies from 960 to 1,000 feet above mean sea level, whereas that of the uplands varies from 1,150 to 1,600 feet. The Ottertail River rises in the hill section and flows in a southerly direction through an extensive network of lakes until reaching Ottertail



Source: Gulf South Research Institute.

Figure I. OTTERTAIL RIVER SUBBASIN

Lake. From this point the river flows westerly to Breckenridge, where it joins the Bois de Sioux River to form the Red River of the North. The only major tributary is the Pelican River, which joins the Ottertail below Fergus Falls. For the most part, surface drainage reaches the Ottertail River or its tributary. Exceptions to this exist in the uplands, where a number of areas lacking surface outlets can be found.

III. PROBLEMS, NEEDS, AND DESIRES

III. PROBLEMS, NEEDS, AND DESIRES

The primary water-related problems, needs, and desires in the Red River Basin are flood control, fish and wildlife conservation and enhancement, recreation, water supply, water quality, erosion control, irrigation, wastewater management, and hydropower. Various water-related problems, needs, and desires have been identified for the Ottertail River Subbasin in previous planning reports on the basis of analysis of conditions and public and agency comments. The list of problems, needs, and desires for the subbasin is the same as the list for the Red River Basin as a whole. But, in general, problems within the subbasin are not as acute as in other subbasins within the Red River Basin. Each problem is discussed separately below, with an emphasis on flooding problems.

Flooding Problems

Nature of the Problems

Most of the periodic flooding within the subbasin is caused by spring snowmelt, sometimes aggravated by rainfall. Although such floods do not result in high direct crop and pasture damage, planting may be delayed up to three weeks from the average seeding date. The delayed seeding results in depressed yields through the affect of hot weather on the immature crop. In addition, given the short growing season, if water stays on the land too long, it may be impossible to engage in planting operations altogether.

Flood damage also occurs from high-intensity summer rains. Although they occur less often than spring snowmelt floods, these summer floods are characterized by high peak flows causing damage to maturing crops or rendering crop harvest impossible.

Two separate types of flooding occur: the most damaging type associated with river bank overflow (overbank flooding) and another type caused by runoff from snowmelt or heavy rainfall impounded by plugged culverts and ditches within sections of land bounded by roadways on earthen fill (overland flooding). In overland flooding, the trapped water slowly accumulates until it overflows the roadways and inundates section after section of land as it moves overland in the direction of the regional slope until reaching river or stream channels.

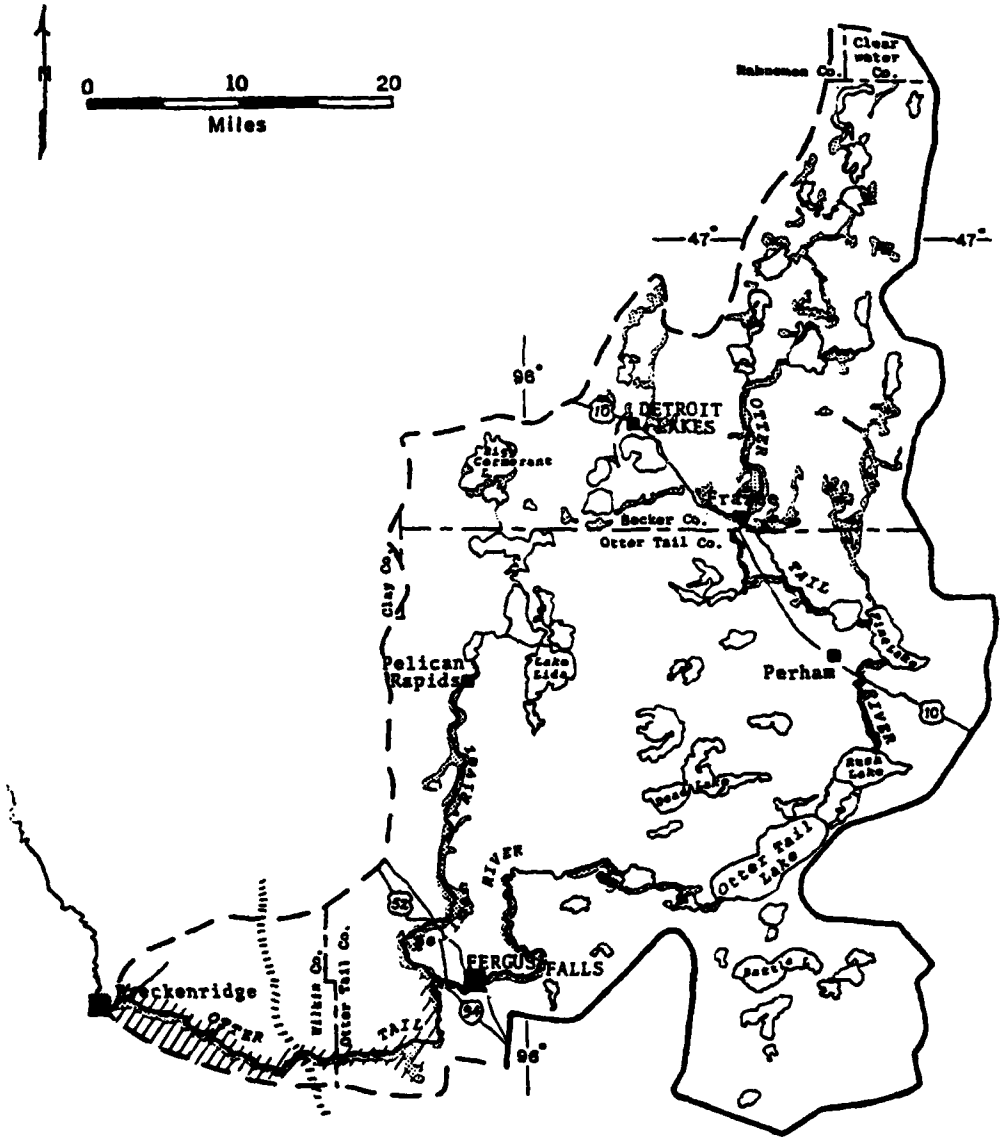
The topography of the subbasin also influences flooding problems. Rolling hills and numerous lakes and depressions characterize the area above the lower 40-mile reach of the Ottertail River. High flows in this area are normally contained within well defined channels and are regulated by passage through several major lakes. The extent of flooding in this area cannot be determined from present sources. Floodplain area maps indicate fairly significant flooding problems, but this is not borne out by descriptive sources. Apparently, some flood problems have resulted from improper regulation of headwater lake levels.

High flows are normally confined within the entrenched channels through the beach ridges of the former glacial Lake Agassiz. The gradient becomes milder and the channel capacity decreases in the downstream 20-mile reach as the river traverses the flat Red River Valley. In this area, floodwaters escape the channel and move overland, damaging cropland, roads, bridges, and farmsteads.

Flood conditions within the subbasin are not generally worsened because of correlation with peak flows on the main stem, since this area is at the headwaters of the Red River. The subbasin, in fact, contributes more to floods on the lower main stem, particularly at the city of Breckenridge. The subbasin constitutes about five percent of the total drainage area of the Red River Basin, and runoff from the subbasin constitutes about six percent of the total Red River flow at the U.S. Canadian boundary.

Location and Extent

Figure II depicts the 100-year floodplain for the subbasin. Prior to this study, no attempt had been made to publish even a generalized delineation of the subbasin floodplain. To produce the present delineation, a number of sources were investigated, including: (1) U.S. Geological Survey (USGS) Flood Prone Area Maps (Scale 1:24,000); (2) Federal Insurance Administration flood maps (various scales); (3) published secondary sources describing flooded areas; and (4) USGS 7 1/2 minute topographic maps. Because of the wide disparity of delineated and descriptive data, the latter is shown in an additional crosshatch pattern.



Source: Gulf South Research Institute.

Figure II. 100-YEAR FLOODPLAIN

Figure II represents a composite of available sources, often supplemented by inferences. Because the sources were generally incomplete and based on surveys of differing detail and accuracy, the map does not constitute a scientific delineation and is useful only for general planning purposes. A more complete description of sources and limitations is given in Appendix A.

According to this provisional delineation, the Ottertail River floodplain is about 50,000 acres in extent. Descriptive sources show another 14,000 acres along the lower reach, expanding the total to 64,000 acres. Major components include: the Ottertail River main channel area, 24,000 acres (delineated sources); the Pelican River floodplain, 8,000 acres; the Toad River floodplain, 8,000 acres; and other tributaries in the northern part of the subbasin, totaling 10,000 acres.

The Ottertail main channel lies in three topographic areas. The upper segment, ending several miles east of Fergus Falls, contains approximately 18,000 acres of associated floodplain that can be characterized as generally well defined, averaging one quarter to one half mile in width, interspersed among numerous lakes. Passing through the beach ridge area around Fergus Falls, the floodplain is more entrenched. From this point to the Ottertail's confluence with the Bois de Sioux, the floodplain is shown on flood insurance maps as maintaining a fairly well defined character, comprising only about 6,000 acres. The Souris-Red-Rainy River Basins Comprehensive Study, however, describes a much larger floodplain area (several miles wide at the lower end) estimated at 20,000 acres (Figure II). Because of the decreased gradient in this near-level glacial lake plain area, it is presumed that the latter estimate has merit.

The floodplain associated with the Pelican River appears more prominent on flood insurance maps than that of the main channel (Figure II). Occurring generally along the beach ridge area, widths vary from less than a quarter mile to over one mile just north of Fergus Falls. As noted, the total Pelican River floodplain is estimated to encompass 8,000 acres. The Toad River floodplain, although not attaining such widths, accounts for an area of comparable size. Other tributaries in the northern hill and lake area have associated floodplains comprising an additional 10,000 acres.

Flood Damages

The primary areas affected by flooding throughout the subbasin are agricultural in nature. There are no significant urban areas affected by flooding, except for the city of Breckenridge, which lies at the confluence of the Ottertail and Red rivers and will be treated in the Red River Main Stem Subbasin report. Most of the land within the downstream portion of the floodplain has been cleared for agricultural purposes, but there is significant forest acreage in the upstream portion of the floodplain. Only urban and rural damages are taken into consideration in the computation of average annual damages. Damage figures were obtained from historic estimates, which were updated through utilization of indexes.

Present average annual damages in the subbasin are $254,000. Relative to the other subbasins, this is a very small figure, accounting for less than one percent of the Red River of the North basinwide flood damage total. Average annual damages are divided into two basic classifications: urban and rural. Urban damages include damages to residences, businesses (commercial and industrial) and public facilities (streets, utilities, sewers, etc.). Rural damages include damages to crops, other agricultural assets (fences, machinery, farm buildings, etc.) and transportation facilities. Rural damages account for 99 percent of total average annual damages in the subbasin, and urban damages account for the remaining one percent.

There were no urban damages reported in the subbasin as a result of the 1975 and 1979 flood events. Average annual urban flood damages in the subbasin (Table 1) total $2,600. Only three other subbasins in the Red River Basin have smaller average annual urban damages. Average annual urban damages are $1,300 residential, $1,000 business, and $300 public.

No rural flood damages were incurred as a result of either the 1975 or 1979 flood events. Average annual rural damages (Table 2), however, are quite substantial. Average annual crop damages are highest ($179,000), followed by other agricultural damages ($60,000) and transportation damages ($13,000).

Table 1

OTTERTAIL RIVER SUBBASIN, ESTIMATED AVERAGE ANNUAL URBAN FLOOD DAMAGES
(In Thousands of 1979 Dollars)

Category	Urban Flood Damage Average Annual
Residential	$1.3
Business	1.0
Public	0.3
Total	2.6

Sources: Red River of the North Basin Plan of Study, April, 1977; and Gulf South Research Institute.

Table 2

OTTERTAIL RIVER SUBBASIN, ESTIMATED AVERAGE ANNUAL RURAL FLOOD DAMAGES
(In Thousands of 1979 Dollars)

Category	Rural Flood Damage
Crop	$178.7
Agricultural	59.6
Transportation	13.0
Total	$251.3

Sources: Red River of the North Basin Plan of Study April, 1977; and Gulf South Research Institue.

Environmental Concerns

Much, if not all, of the prairie in the western portion of the subbasin (primarily Wilkin County) has been cleared for agricultural and domestic uses, and riparian communities in this region are also severely limited. This has resulted in the provision of low-quality wildlife habitats. Given the scarcity of natural resources in this part of the subbasin, land use conflicts exist between agriculture and wildlife interests in regard to wetland drainage (Upper Mississippi River Commission, 1977; North Central Forest Experiment Station and Minnesota State Planning Agency, no date). There is a need to conserve the remaining wetlands and woodlands in the western part of the subbasin, and where practical, to enhance habitats for floral and faunal resources.

Environments for aquatic biota are excellent in the upper reaches of the Ottertail River, and a need has been expressed to maintain these conditions. However, high concentrations of municipal, industrial, and agricultural pollutants have been reported, which are probably affecting aquatic organisms. Eutrophication problems have been reported in several of the area's lakes, as well as problems with significant water level fluctuations (affecting fish populations and fishing) in lakes such as Orwell Reservoir. These are problems that need to be rectified. In addition, inadequate stream flows occurring in the Pelican River and small tributaries to the Ottertail during dry periods of the year create problems with regard to waste assimilation and minimum streamflow requirements for recreational usage (e.g. fishing). The overall shallowness of the Pelican River further aggravates conditions for aquatic biota by reducing the amount of available permanent habitats (Minnesota Pollution Control Agency, 1975; Minnesota Water Resources Board, 1967; U.S. Fish and Wildlife Service, 1979; Upper Mississippi River Commission, 1977).

Recreation Problems

The subbasin has an abundance of water-based and water-related recreational opportunities. Problems related to recreation in the subbasin do not stem from the lack of large water bodies as is the case in many parts of the Red River Basin, but from natural processes and certain practices by man that diminish resource quality. Primary areas of concern include: (1) erosion; (2) unplanned residential and resort development; (3) water pollution; and (4) the drainage of wetlands.

Soil erosion, caused by certain soil type characteristics, climatic conditions, and intensive farming techniques, results in siltation and the accelerated eutrophication of many of the lakes and streams in the region. The increase in noxious aquatic plant growth in lakes, due to the introduction of agricultural fertilizers through erosion, limits water-related recreational activities.

Many of the residential and resort areas in the lake region have been developed without planning for adequate sewage facilities and without construction codes designed to control erosion along lake banks. The result has been increased erosion, water pollution, and general lowering of recreational and aesthetic potential.

Water pollution due to siltation, turbidity, and the lack of proper sewage treatment in some areas is incompatible with optimum recreational and aesthetic benefits. Problems resulting from erosion, unplanned development, and water pollution are particularly acute in the vicinity of Detroit Lakes and the lower Ottertail River near Breckenridge.

The area's wetlands constitute an important resource, providing wildlife habitat for a variety of species. Wetland areas are lacking in many portions of the Red River Basin because of drainage for agricultural purposes. Excessive drainage in the future could diminish the ecological and recreational diversity of the subbasin.

Water Quality Problems

Some quality problems in the subbasin are related to high levels of municipal, industrial, and agricultural pollutants. The major area of concern is in the Fergus Falls or Pelican River confluence region and in areas downstream from these sites. High concentrations have been reported for total suspended solids, ammonia, phosphorus, oil, and bacteria. Eutrophication problems have been reported in area lakes such as in the Cormorant Lakes chain that result from elevated nutrient levels. Problems also occur in the Pelican River and small tributaries to the Ottertail River because of inadequate streamflows in the late summer, fall, and winter months. Their condition results in a lowering of the assimilative capacity of the stream. With regard to groundwater quality, high iron and manganese concentrations have been reported in certain areas (Minnesota Pollution Control Agency, 1975; Minnesota Water Resources Board, 1967; Upper Mississippi River Commission, 1977).

Water Supply Problems

The outwash area of the subbasin covers 350 square miles and contains 1.5 million acre feet of water in storage; however, only a relatively small amount is economically recoverable. Some groundwater supplies are high in iron and manganese concentrations. Pelican Rapids is served by an artesian aquifer that is limited in areal extent. Some yields have declined because of encrustations on well screens, and test drilling will be necessary to locate new wells within the aquifer. Surface water is widespread through most of the subbasin, but full development is limited by low flows, evaporation and seepage losses, and the lack of suitable reservoir sites in the valley. A sustained streamflow supply requires storage of high flows, but the presence of large groundwater reservoirs and numerous lakes and swamps reduces peak flows in streams. The average discharge of the Pelican and Ottertail rivers is half as much in the lower reaches of each river as in the upper lake region. Because of this condition, it is necessary to use groundwater to supplement surface supplies during summer months in Fergus Falls.

Erosion Problems

The character of glacial deposits and climatic conditions has determined, in large part, the type of soils found within the area. The silty clay loams in the central and western sections of the subbasin are highly fertile, but by the nature of their composition and local topography, these soils are susceptible to wind erosion and drifting. Sandy loams occurring in a large part of the subbasin near beach ridges and in the hilly areas are highly vulnerable to wind and water erosion. Erosion results in the loss of valuable topsoil and some sub-soil and in increased maintenance costs for natural drainageways, roads, and drainage ditches. Fertile soils that have been treated with fertilizers are transported by erosion to area lakes and streams. This often results in water pollution and the rapid growth of aquatic plants, which limits the potentials for recreational usage. Land treatment programs are necessary to control erosion problems in the subbasin.

Irrigation

The subbasin is located in west central Minnesota, where irrigation practices have been on a constant increase since the 1930's. Although

the initial investment for equipment is relatively large, many farmers who have proper soil and water conditions will invest in an irrigation system to reduce the climatic risk involved in agriculture. This practice is likely to continue to increase in the subbasin because groundwater supplies are plentiful throughout much of the area.

The amount of irrigated acreage in west central Minnesota constitutes more than 30 percent of the total irrigated acreage in Minnesota. Between 1970 and 1974, the irrigated acreage in Becker County increased from 275 acres to 945 acres, which was a 244 percent increase. The irrigated acreage in Ottertail County increased by the same percentage, from 4,328 acres to 14,852 acres. In 1970 only 10 acres were irrigated in Wilkin County, but in 1974, more than 500 acres were irrigated.

County agents in the area feel that the trend toward increased irrigation will continue well into the future. Increased irrigated acreage may lead to the development of specialty crop farming and may encourage the location of more agricultural processing plants in the subbasin. Increased irrigation may seriously impair the availability of groundwater for future municipal, industrial, and agricultural needs if this resource is not managed correctly.

Wastewater Management

Table 3 enumerates the point source dischargers in the subbasin as well as their problems, treatment needs, and other planning considerations. None of the 11 municipal wastewater treatment facilities in the subbasin provide adequate treatment. The major problem is the failure to remove phosphorus, which is affecting lakes. The remaining 10 point sources (six municipal water treatment works and four industries) are also contributing to pollution to varying degrees in the Ottertail River in the form of non-compliant values of fecal coliforms and high levels of nutrients and grease. Past data indicate that discharges in the Fergus Falls area were causing the violation, although this may not be the case now. Turbidity violations and fairly high levels of total suspended solids have been reported near the mouth of the Ottertail River and may be caused by natural or agricultural-related erosion (Minnesota Pollution Control Agency, 1975).

Table 3

PROBLEMS AND TREATMENT NEEDS FOR POINT SOURCE DISCHARGERS IN THE OTTERTAIL RIVER SUBBASIN

Discharger	Problems	Treatment Needs	Other Planning Considerations
Dent	System leaks	Repair leakage in ponds	If ponds are repaired no discharge should occur--no permit required
Frazee	System leaks; may be at capacity; no phosphorus removal	May require repair and expansion; phosphorus removal	Interim effluent limits in permit Low on MNL
Frazee Water Treatment Works	No treatment	Treat wastes or connect to municipal system	Contract for connection
Vergas	System leaks; no phosphorus removal	Repair leakage; phosphorus removal	Interim effluent limits in permit Low on MNL
Perham	Plant is overloaded and is incapable of meeting final standards	New facility or advanced phosphorus removal	Low on MNL
New York Mills	No chlorination or phosphorus removal; excessive BOD levels	Chlorination equipment; phosphorus removal may be required	Must study (1) alternative methods of waste disposal: (2) effect of effluent on Rush Lake
New York Mills Water Treatment Works	No treatment	Treat wastes or connect to municipal system	Contract for connection
Battle Lake	Plant incapable of meeting standards; no phosphorus removal	New facility or advanced treatment--phosphorus removal	Interim effluent limits in permit
Detroit Lake Water Treatment Works	No treatment	Treat wastes or connect to municipal system	Contract for connection
Detroit Lakes	No phosphorus removal; no other apparent problems	Phosphorus removal; tertiary treatment	New facilities apparently completed
Lakeview Township	Inadequate treatment: wastes are causing eutrophication problems	Build new facility or connect to Detroit Lakes system	Situation being re-reviewed by MPCA; Township is on project list for Step II-Permit 180 days before discharge
Becker Company, Sand and Gravel	Nature of problems not known	Not known	--
Pelican Rapids	Present facility is incapable of meeting effluent standards	New facility or advanced treatment; control overflow	---
Pelican Rapids Water Treatment Works	No treatment	Treat effluent or connection option	Applied for construction permit to connect to facility used for West Central Turkeys
West Central Turkeys	Nature of problems not known	Not known	Treatment facility operated by Pelican Rapids
Elizabeth	No treatment	New facility	Is receiving Step II Grant; apply for NPDES Permit 180 days prior to discharge
Fergus Falls	Present facility is incapable of meeting effluent standards	New facility or upgrading; phosphorus removal; control overflow	Eligible for Step I grant must make study of Nutrient Budget for Dayton Hollow Reservoir
Mid-American Dairymen	--	Not known	--
Fergus Falls Water Treatment Works	In violation of pH standards; no other apparent problems	Treat effluent	--
Ottertail Power Company	Temperature violations; other problems not known	Increased capacity to cool water	Variance Hearing Authorized
Breckenridge Water Treatment Works	No treatment	Treat wastes or connect to municipal system	Contract for connection

Hydropower

There are several hydroelectric installations in operation on the Ottertail River within the subbasin.. Two dams northeast of Fergus Falls which have hydropower capabilities include Friberg (Caplin Gorge) and Hoot Lake. West of Fergus Falls are three small facilities called Central (Wright), Pisgah, and Daytons Hollow. A small dam located at Frazee was installed as a hydroelectric plant, but these facilities have now been removed. Although there are no plans at this time to install additional hydroelectric plants, local power company officials have indicated that the large public dam (Orwell) south of Fergus Falls has potential for development.

Public Perception of Problems and Solutions

The public's perception of problems and solutions in the subbasin is not adequately defined because the Corps of Engineers has not held any recent public meetings in this area, and only a portion of the subbasin has been organized as a watershed district. Informal meetings, however, have provided a reasonable forum for exchanges concerning water resource problems.

The primary documents for the identification of public perceptions are the 1953 Master Plan for Management of Orwell Reservoir (and Supplement No. 1, December 1967) and the overall plan for the Cormorant Lakes Watershed. The first document stems from a 1953 public meeting in Fergus Falls in which flood control and wildlife management were discussed. The plan further includes measures for erosion and noxious weed control and retardation of reservoir siltation. In 1954, the flood-carrying capacity of the Ottertail River below the reservoir was improved by the Corps of Engineers through straightening, clearing, and enlarging. In the 1967 supplement, consideration of water-oriented recreation at Orwell was rejected because of fluctuating water levels necessary for flood control.

The second document mentioned above was prepared by the Cormorant Lakes Watershed District, located in the southwest corner of Becker County, and can only be used as a reflection of local interests and desires. At that time, the primary water-related needs identified for the Cormorant Lakes area were land and water conservation, water quality, water-oriented

recreation, and drainage. At present, channel improvements and outlet controls in the vicinity of big Cormorant Lake are being considered as potential flood control measures.

It may be inferred from these documents that the public has an interest in similar measures, particularly those that would further reduce flooding problems and would further enhance recreational and wildlife values.

Additional evidence for interest in flood control measures is contained in public hearings held in East Grand Forks in 1978 and 1979 before subcommittees of the Committee on Public Works and Transportation of the U.S. House of Representatives. From these documents, it is evident that residents of the Red River Basin consider flood control to be the primary water related need for the area and that they are interested in whatever solutions may be proposed by Federal, state, or local agencies.

IV. DESCRIPTION OF SUBBASIN RESOURCES

IV. DESCRIPTION OF SUBBASIN RESOURCES

This section of the report discusses the primary resource conditions within the subbasin that are water-related and that would be affected by a comprehensive water and related land resources plan centering on flood control measures.

Social Characteristics

The population of the subbasin has shown a slow but steady increase since 1920. Between 1970 and 1977, the subbasin experienced an 8.6 percent increase in population—from 47,400 to 51,494. This recent increase was the result of an increasing inmigration rate in the two counties that constitute the major portion of the subbasin (Becker and Ottertail). Between 1970 and 1977, Becker had an inmigration rate of 8.9 percent, and Ottertail's inmigration rate was 6.4 percent. Preliminary figures for 1978 indicate that these counties are still experiencing inmigration. Telephone contacts with public officials indicate that the inmigration pattern results from: (1) the decline in the farm consolidation rate; (2) increased parental turnover of farms to sons and daughters; and (3) the attractiveness of the lake region for retired persons.

The largest city in the subbasin is Fergus Falls, which is located on the Ottertail River. Fergus Falls' population was 11,933 in 1977, which was a 4.1 decrease from 1970. The second largest city is Detroit Lakes (6,422), which experienced a 2.6 percent decrease in population from 1970. Most of the other towns in the subbasin are quite small, but many of them have shown increases in population between 1970 and 1977. The rural population in 1977 was approximately 30,000, which was a 21 percent increase over 1970. The decreasing population of the cities in favor of smaller rural towns is viewed by selected officials as the result of several factors, such as: (1) the lack of large manufacturing concerns in the major cities to provide jobs; (2) fewer taxes in the rural areas; and (3) a general trend toward owning "a piece of land."

The population density for the subbasin increased from 24.7 persons per square mile in 1970 to 26.8 persons per square mile in 1977. Ottertail is one of the most densely populated subbasins in the Red River of the North Basin. The population is primarily of Norwegian background. The

minority population is very small, but there is a significant American Indian representation. Most of the land area of the White Earth Indian Reservation lies in the portions of Mahnomen and Clearwater counties that are outside the subbasin boundaries; however, most of the reservation's population (approximately 1,400) lives in the Becker County segment of the study area. Census data for 1970 indicates the American Indian population comprises 5.1 percent of the total population for Becker County.

Communities of the basin are close-knit, as can be partly illustrated by the length of residence in the area. The major population centers are located within Becker and Ottertail counties, in which 79.3 percent and 81.8 percent of the residents, respectively, own their homes. Approximately 59 percent of the 1970 Becker County population was living in the same residence in 1965, and 80 percent was living in the same county. In Ottertail County, approximately 65 percent had occupied the same residence since 1965, and 84 percent was living in the same county.

Economic Characteristics

Employment

Between 1940 and 1970, farm employment in the subbasin steadily decreased as a result of mechanization and the move to large-scale farming. Although agriculture has declined, it will continue as a major source of employment. Since 1970 agricultural employment has increased slightly in every county within the subbasin. The most significant employment increases, however, have occurred in the services sector (mostly tourism and recreation-related) and in the wholesale and retail trade sectors. The result of the shift from agriculture-related to nonagriculture-related employment has been a total employment increase of 29 percent--from 18,012 in 1970 to 23,172 in 1977.

Unemployment in the subbasin averaged seven percent during the 1970's. Employment is high during the spring and summer because of agricultural activities and tourism and during the fall because of harvesting and processing activities.

Income

Total personal income for the subbasin increased from $217 million to $302 million between 1969 and 1977 (as expressed in 1979 dollars).

Farm income accounts for only 15 percent of the total personal income in the Becker County portion of the subbasin because the area is heavily forested, has numerous lakes, and is occupied by the city of Detroit Lakes, which has a great deal of trade, services, and industries. Farm income accounts for about 25 percent of the total personal income in Ottertail County, but income from the urban center of Fergus Falls is constituted primarily by government, trade, manufacturing, and transportation services. In the southwestern portion (Wilkin County) of the subbasin, the land is used primarily for agricultural purposes because the valley is fertile and largely unpopulated. Farm income in this area accounts for almost 50 percent of the total personal income.

Average per capita income in the subbasin between 1970 and 1977 increased from $4,575 to $5,867, which was 30 percent below the 1979 state average of $8,314. This is one of the lowest per capita income figures in the Red River Basin.

Business and Industrial Activity

Agriculture

Agriculture and related economic activities provide the primary force behind the economy of the subbasin. Agricultural operations in the area are largely dependent upon the family operated farm. These operations primarily produce small grains. In addition, livestock and livestock products contribute a large share of the cash income of many of the farming units. Livestock production is more prevalent in Ottertail and Becker counties than in Wilkin County. In 1974, more than 65 percent of the total sales receipts of agricultural products in Becker and Ottertail were due to the value of livestock. Only 11 percent of Wilkin's agricultural sales were due to the sale of livestock.

Approximately 45 percent (or 552,960 acres) of the subbasin's land area is under cultivation, 23.7 percent is forested, and 11.7 percent is devoted to pasture. The major crops grown in the subbasin are identified in Table 4. Hay and wheat are the leading crops, followed closely by corn and oats. These crops account for 81 percent of the harvested acreage. Barley and sunflowers account for another 17 percent of the total acreage,

and sugarbeets, rye, flax, and soybeans collectively represent two percent of the harvested acreage.

Table 4

1978 CROP STATISTICS, OTTERTAIL RIVER SUBBASIN

Crop	Harvested Acres	Yield Per Acre	Total Production
Hay	136,600	2.2 tons	300,520
Wheat	103,260	31.1 bushels	3,211,386
Corn	102,778	72.9 bushels	7,492,516
Oats	99,121	55.9 bushels	5,540,864
Barley	59,000	47.5 bushels	2,802,500

Source: Gulf South Research Institute.

Manufacturing

The majority of the manufacturing establishments in the subbasin (Table 5) are located in the cities of Detroit Lakes and Fergus Falls, where 35 percent of the subbasin's populace lives. These manufacturers have been attracted by proximity to agricultural areas, and high ground for development. Both Fergus Falls and Detroit Lakes have industrial corporations that actively seek new industries. Most of the 62 manufacturing establishments are involved with agricultural or wood products. The two largest employers (between 750 and 1,250) are plants that process turkeys. At least 10 of the manufacturers employ more than 100 people. Almost 50 percent of the manufacturing establishments are located in the city of Fergus Falls.

Table 5

MANUFACTURING ESTABLISHMENTS, OTTERTAIL RIVER SUBBASIN

SIC	Description	Estimated Employment
20	Food and Kindred Products	1,850
23	Apparel made from fabrics	200
24	Lumber and Wood Products	600
25	Furniture and Fixtures	50
27	Printing and Publishing	100
28	Chemicals and Allied Products	35
32	Stone, Clay and Glass Products	50
34	Fabricated Metal Products	600
35	Machinery, except Electrical	40
36	Electrical and Electronic Machinery	50
38	Measuring, Analyzing and Controlling Instruments	25
39	Miscellaneous Manufacturers	25
TOTAL		3,625

Source: 1979-1980 Minnesota Directory of Manufacturers.

Trade

In 1977, total trade receipts for the subbasin exceeded $307 million (expressed in 1979 dollars). More than 50 percent (or $154 million) of the receipts were retail trade. Wholesale trade and selected service receipts were $153 million and $16.2 million, respectively, in 1977.

Transportation Network

The most important highways in the subbasin run primarily east and west and include Federal Highway 10 and Interstate 94. Interstate 94 runs through Fergus Falls and provides fast, efficient access to both the Fargo-Moorhead area and the Minneapolis-St. Paul area. Federal Highway 10, which runs through Detroit Lakes and Perham, also provides access to Fargo-Moorehead. East of the subbasin, it connects to State Highway 210, which travels to the Port of Duluth. In addition to these major highways, the subbasin

has numerous state and county roads, many of which connect to the major arteries to provide access to the urban centers of the state.

The subbasin is also traversed by two rail lines that generally parallel the major highways and travel to the cities of Fargo-Moorhead, Minneapolis-St. Paul, and Duluth. The Burlington Northern passes through Detroit Lakes, Perham, Fergus Falls, Pelican Rapids, and Elizabeth, and the SOO Line runs through Detroit Lakes and Ottertail. One natural gas pipeline crosses the subbasin near Perham, and another passes near Fergus Falls. Two petroleum product lines cross the subbasin in the vicinity of Pelican Rapids and Fergus Falls. Both Fergus Falls and Detroit Lakes have airports that provide services to the surrounding area. Small airports with grass runways and very limited services are located at Perham, Battle Lake, and Pelican Rapids.

Land Use

Approximately 44.9 percent of the subbasin is under cultivation, 23.7 percent is forest, 13.9 percent is water, 11.7 percent is pasture, and 2.6 percent is urban. Cultivated areas are the dominant land use, except in the northern part (Becker County) of the subbasin, where forests are dominant. Large forested areas are also found in Ottertail County and along river and stream beds throughout the remainder of the subbasin, with the exception of the Red River Valley area. Surface water areas (primarily lakes) comprise more than 10 percent of the total surface area in Ottertail and Becker counties. These counties also have higher percentages of pasture land and open space because of the presence of less fertile soil and steep slopes. These areas are used for livestock production because they are undesirable for cultivation.

Land use in the floodplain follows the same pattern as land use throughout the subbasin. The floodplain in the southwestern half of the subbasin is under cultivation, whereas the floodplain in the middle and northern portions has more forested areas. The towns of Fergus Falls, Pelican Rapids, Elizabeth, Erhard, and Cormorant are located in various floodplain areas.

The trends in agricultural land use include: (1) drainage of wetlands, marshes, and sloughs to increase tillable acreage; (2) increased tillage of slopes; (3) tillage of soils having low fertility; (4) increased use

of irrigation; and (5) removal of existing shelter belts and windbreaks. In addition to these intensified farm practices, there has been an increase in farm size and a decrease in the number of farms. The nonagricultural land use trends include: (1) growth of residential development in aesthetic areas; (2) growth in the amount of land committed to utility and transportation corridors; and (3) growth of commercial activity in rural areas.

Environmental Characteristics

Climate

Climatological data is available from the U.S. Weather Bureau stations in Detroit Lakes and Fergus Falls. The subbasin is characterized by wide fluctuations in temperature and summer thunderstorms, which is typical of continental climatic patterns. The mean annual temperature is 40.8°F, with extremes ranging from 53°F below zero to 112°F. The growing season normally occupies a 127-day period from mid-May to late-September, but frost can occur as late as June and as early as August.

Flooding problems are caused, in part, by snowmelt coinciding with spring rainfall. The annual precipitation is 23.11 inches, with 16 percent, or 37 inches, occurring as snowfall. The majority (70 percent) of annual precipitation, however, is in the form of rainfall caused by localized thunderstorms, which move eastward across the area. The most intense rainfall activity occurs in the northern portion of the subbasin.

Geology

The subbasin lies within the Western Lake Section in the Central Lowland Province of the Interior Plains. Bedrock is predominantly undifferentiated Precambrian igneous and metamorphic rock overlain by Cretaceous sediments of the Dakota Group composed of sandstone and interbedded shale. The Colorado Group is shale with thin shaley limestone and a micaceous clay unit at its base.

Glacial deposits of clay, loam till, sandy till and sands and gravels overlie bedrock and are from 300 to 500 feet thick in the subbasin. The weathering of these deposits has produced the fertile agricultural soils of the region. Swamps, beach ridges and level lands are features characteristic of glacial geology.

The eastern portion of the subbasin contains the largest concentration of ice-contact and outwash deposits underlain by sand and gravel in the Red River Basin. These deposits yield large quantities of groundwater for municipal and domestic use. In addition, the extensive sand and gravel areas account for Ottertail County's position as one of the state's leading producers of these materials.

Biology

The subbasin lies within three major vegetation formations in Minnesota: prairie, deciduous forest, and pine-hardwoods forest (Wanek, 1967). The prairie, now converted to agricultural lands, occurs in Wilkin County and in the western portion of Ottertail County. The deciduous hardwood and pine-hardwoods forest comprise the remaining land area. Principal forest types in the subbasin include the elm-ash-cottonwood, maple-basswood, aspen-birch, pine, and spruce-fir communities. The elm-ash-cottonwood type occurs as a limited riparian association in certain locales along the Ottertail River between Fergus Falls and Breckenridge and in scattered locations through Ottertail County and southern Becker County. Common plant taxa include American elm, green ash, cottonwood, hackberry, boxelder, silver maple, willow, and hawthorn. The maple-basswood type is an abundant community in mesic situations from Fergus Falls in the south to the Tamarac National Wildlife Refuge in the north. Predominant trees in this type are sugar maple, red maple, basswood, and yellow birch. The aspen-birch type is found west of the community of Detroit Lakes and constitutes a major forest type north of the Tamarac National Wildlife Refuge into Clearwater County. This community is comprised of species such as aspen, paper birch, snowberry, and red-osier dogwood. The pine community is situated in the upper reaches of the subbasin from Flat Lake north to Many Point Lake and consists predominantly of white pine or red pine. The spruce-fir type is located in small scattered areas of the Tamarac National Wildlife Refuge and is composed of species such as balsam fir, white spruce, black spruce, tamarack, or northern white cedar (North Central Forest Experiment Station and Minnesota State Planning Agency, no date; Wanek, 1967).

Wetlands in the subbasin fall within two major wetland zones delineated by Mann (1979): Red River Valley Lake Plain and Border-Prairie Transition. The Red River Valley Lake Plain Zone is found within the flatter segments of the river valley floor in Wilkin County and extreme eastern Ottertail County. Shallow wetlands and native prairie once occurred in this zone but have been converted almost totally to agricultural lands. Residual wetlands are composed mainly of Type I wetlands (seasonally flooded basins or flats), which hold water in the spring or following heavy rains. The Border-Prairie Transition Zone includes the remainder of the subbasin and includes five wetland types: Type III--shallow fresh marshes; Type IV--deep fresh marshes; Type V--open fresh marshes; Type VI--shrub swamps; and Type VII--timbered swamps (Mann, 1979; U.S. Fish and Wildlife Service, 1977). Delineation of the wetland zones will be made later in the significant resources section.

Habitat types of importance to wildlife in the subbasin consist of any remaining grasslands, woodlands, and wetlands. The grasslands in combination with wetlands form a dynamic and diverse ecosystem that supports an abundance of faunal species. However, conversion of these grasslands to agricultural lands has significantly reduced this important habitat in the extreme western portion of the subbasin. Woodlands and brushy areas are important habitats for wildlife, since they provide resting, feeding, breeding, and nesting habitats. These habitats should be preserved because they afford environs for a greater variety of wildlife species than other principal habitat types found in the subbasin. Wetlands in association with aquatic systems (e.g., lakes and streams) afford excellent habitats for aquatic biota by providing cover and a source of nutrients for both vertebrate and invertebrate organisms. These wetlands, as well as those found in upland situations, afford essential breeding, feeding and resting areas for migrating waterfowl and breeding and rearing habitat for big and small game, furbearers, and other forms of wildlife.

The white-tailed deer is the most abundant big-game animal in the subbasin, with 1978 firearm harvest figures ranging from 89 in Wilkin County to 1,654 in Ottertail County. Black bear occur in the northern half of the subbasin. The 1978 harvest indicated 12 bears taken in Becker County,

three in Mahnomen, and two in Clearwater. Some moose may occur in the headwaters in Clearwater County. Other common game mammals include the gray squirrel, jackrabbit, and cottontail. Typical upland game birds include the pheasant, ruffed grouse, and sharp-tailed grouse (male densitites of four to six/square mile in upper reaches of subbasin). Characteristic furbearers consist of the gray fox, bobcat, muskrat, beaver, mink, and raccoon. The otter reaches the southern limit of its range in Minnesota in the upper reaches of the subbasin. The otter, however, can be found along the Mississippi River to Iowa.

Waterfowl species breeding in the potholes and shallow marshes include the mallard, pintail, blue-winged teal, wood duck, redhead, ruddy duck, and coot. A total of 103 species of breeding birds have been reported from the region (DNR Management Unit, Region 15): non-native pest birds--three species; non-native game birds--two species; native game birds--15 species; and native nongame birds--83 species. Common nongame breeding birds include the killdeer, horned lark, yellowthroat, yellow-headed blackbird, and vesper sparrow. Colonial bird nesting sites within the subbasin include Cotton Lake (common tern), Franklin Lake (great blue heron and possibly black-crowned night heron), Orwell Reservoir (western grebe), Dead Lake (great blue heron), and Star Lake (great blue heron).

Seventeen species of herpetofauna have been reported from the region, which includes the majority of the land area in the subbasin (Wilkin, Ottertail, and Becker counties). Common species include the common snapping turtle, northern prairie skink, western plains garter snake, and mudpuppy. Thirty nongame mammals are known from the counties occurring in Region 1S of the subbasin and are comprised of species such as the eastern chipmunk, deer mouse, meadow vole, meadow jumping mouse, short-tailed weasel, and striped skunk (Henderson 1978a and b, 1979a and b; Henderson and Reitter, 1979; U.S. Fish and Wildlife Service, 1980).

The upper reaches of the Ottertail River flow through numerous lakes, ponds, and marshes that provide clear, clean, gravel-bottomed aquatic habitats for aquatic biota. Water levels and discharges are constant and flooding is rare. High stream gradient and deep gorges are characteristic of the middle reaches of the Ottertail in which a number of hydroelectric dams and reservoirs (Central, Pisgah, Dayton Hollow, and Orwell dams) have been

constructed to provide electric power to the Otter Tail Power Company in Fergus Falls. In the lower reaches in the lake plain region, the river becomes a slow, muddy plains stream.

The Ottertail River has been classified as a warmwater gamefish (Class II) stream, with major fish species composed of walleye, northern pike, largemouth bass, and several pan fish species (a total of 44 fish species have been identified in the river). The Pelican River, classified as a warmwater feeder (Class III) stream is a major tributary to the Ottertail River. It originates in Detroit Lake and flows through other lakes before joining with the Ottertail at Fergus Falls. The shallowness of the river limits the amount of permanent fish habitat which, in turn, has caused low fish populations. Some fishing occurs below Bucks Mill and Lake Lizzie dams for smallmouth bass, crappie, and other species mentioned for the Ottertail River (42 species of fish have been reported in the Pelican River). Three trout species occur in the subbasin: brook and brown trout in Sucker Creek and rainbow trout in Bass Lake (U.S. and Wildlife Service, 1980).

A characterization of fish and game lake resources occurring within the six counties included by the subbasin is given in Table 6. Emphasis should be placed on the data for Wilkin, Ottertail, and Becker counties, since a larger amount of the land area within these counties is contained within subbasin boundaries than is the case for the remaining three.

Cvancara (1970) reported on the mussels occurring within the Ottertail River. He collected the following species: Fusconaia flava, Amblema costata, Lasmigona complanata, L. compressa (empty shells), L. costata (empty shells), Anodonta grandis, Anodontoides ferussacianus, Ligumia recta latissima, Lampsilis siliquoidea and L. ventricosa.

Water Supply

Groundwater supplies are used in most parts of the subbasin. Extensive ice-contact and outwash deposits contain numerous glacial sand and gravel artesian aquifers that yield adequate quantities of water for municipal and rural needs in the eastern portion of the subbasin. There are large volumes of groundwater storage, which is reflected in the many lakes in the area, and which also sustains the lakes during dry cycles. Detroit

Table 6

FISH AND GAME LAKE RESOURCES, BY LAKE TYPE, IN THE COUNTIES INCLUDED IN THE OTTERTAIL RIVER SUBBASIN

	County											
	Becker		Clay		Clearwater		Mahnomen		Ottertail		Wilkin	
Type	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Dry Lake Basins[1]	32	2,379	2	68	1	24	4	262	27	1,110	-0-	-0-
Game Lakes[2]	249	20,709	57	1,930	47	7,394	188	7,326	605	31,184	24	523
Marginal Lakes[3]	263	25,669	36	2,026	35	2,110	57	5,413	267	26,633	-0-	-0-
Fish and Game Lakes[4]	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	4	515	-0-	-0-
Fish Lakes[5]	113	--	4	--	37	--	10	--	131	--	1	--
Unclassified Lakes[6]	48	6,019	1	38	28	3,601	5	1,466	72	28,110	1	150
Centrarchid Lakes[7]	22	13,013	3	399	7	2,290	2	1,520	20	12,695	-0-	-0-
Walleye Lakes[8]	13	13,056	-0-	-0-	-0-	-0-	2	1,567	13	72,140	-0-	-0-
Trout Lakes[9]	2	57	-0-	-0-	-0-	-0-	-0-	-0-	1	21	-0-	-0-

[1]Dry lakes as reported here include those basins that do not have standing water throughout the year. This includes drained lake basins, dry basins with emergent vegetation such as cattails, and shrub swamps.

[2]Game lakes are those lakes shallower than six feet which ordinarily contain water throughout the years. They are ordinarily designated as being Type III or Type IV marshes.

[3]Marginal lakes are those that range from six to 20 feet deep, winterkill, and frequently have rough fish populations. Lakes with inlets are most likely to have rough fish populations.

[4]Fish and game lakes are defined as lakes in which both the game and fish resources are of major importance. These are lakes with several distinct connected basins, some river lakes, impoundments (especially the navigation pools on the Mississippi River), and the northern pike--wild rice--waterfowl lakes.

[5]Fish lakes are those that do not winterkill and have maximum depths that are ordinarily more than 20 feet and average depths that are 10 feet or more. Some soft water lakes, however, have average depths less than 10 feet and do not winterkill, and some fertile shallow lakes have inflows of water that add sufficient oxygen to prevent winterkills.

[6]Unclassified fish lakes are those where sufficient information is available to determine that they do not winterkill and are definitely fish lakes, but data available does not justify further classification. This category also includes a few lakes that do not readily fall into the remaining categories. For example, rough fish lakes that do not winterkill.

[7]Centrarchid lakes are those having fish populations that are primarily composed of bluegills, pumpkinseed, crappies, rock bass, largemouth bass, and/or smallmouth bass. These lakes frequently have good populations of northern pike. Some of these lakes contain populations of walleye that are either artifically maintained or are a natural population that is a small fraction of the total fish population. In the northeastern part of the state smallmouth bass and rock bass tend to be the most important segments of a centrarchid population in a lake. Crappies and green sunfish are the centrarchids that occur most commonly in very eutrophic southern lakes.

[8]Walleye lakes are those having walleyes, yellow perch, common suckers, northern pike, and frequently tullibee as the main constituents of the fish population. Sometimes these lakes have fair sized populations of centrarchids, but they tend to be restricted to protected areas such as shallower weedy bays.

[9]Trout lakes are those containing known populations of trout, either naturally or maintained by stocking.

Source: Peterson (1971).

Lakes is the largest town utilizing groundwater resources. The city required 450,000,000 gallons of water in 1979. During summer months, it is sometimes necessary to pump water from the city's one million gallon storage tank; however, local officials consider the groundwater sources to be adequate for future demands.

Fergus Falls, located in the western portion of the subbasin, is the only major population center depending on surface water supplies. The city used 628,701,000 gallons of water obtained from the Ottertail River in 1979; however, wells are maintained to supplement supplies during drought periods. Detroit Lakes, Fergus Falls, Frazee and Pelican Rapids use significnat amounts of water for sugarbeet, potato, and turkey processing plants.

Water Quality

The Ottertail River has been classified as Water Quality Limited for the following reasons: (1) periodically the stream flows are not sufficient to provide enough dilution to maintain water quality standards after introduction of secondarily (or best practically) treated effluents; and (2) non-point sources are expected to cause violations of water quality standards. The need for tertiary treatment does not apply to the river at Fergus Falls, since a load allocation study indicated that this stream reach had ample flow to adequately assimilate wastes from secondary treatment (Minnesota Pollution Control Agency, 1975). Problems and treatment needs for point source dischargers were described earlier in the Problems and Needs section under the Wastewater Management discussion.

Water quality data for the Ottertail River at three monitoring stations are shown in Table 7. The earlier data shown for Fergus Falls indicated that quality was good upstream of the town, with violations apparent only for eight percent of the fecal coliform samples. Quality of the river was degraded below the town, with 54 percent of the fecal coliform samples in violation and increased concentrations of ammonia, phosphorus, turbidity, and total suspended solids. Improvements in quality have probably been realized with treatment improvements, but the data indicated that dischargers at Fergus Falls or on the Pelican River were having a significant adverse impact on water quality in this region (Minnesota Pollution Control Agency, 1975).

Table 7

WATER QUALITY DATA FOR THREE MONITORING S

Description	Flow (cfs)	Temperature (°F)		D.O. (mg/l)		BOD_5 (mg/l)		NH_3 (mg/l)		Fecal Coliform (MPN/100 ml)		T (mg/
Water Quality Standards in this Segment		5° change 86° Maximum		6-4/1-5/31 5-rest of year		--		1.0		200		70
Monitoring Stations	Average 7-Day 10-Year Low	Average Maximum	Percent of Violation	Average Minimum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum
07-67		53				2.6		0.07		120		231
Bridge CSAH-1 East of Fergus Falls	--		-0-	--	--		-0-		-0-		8	
13 reports, 1967-1968		73				5.0		0.21		1,300		
07-69		57				3.3		0.16		1,271		197
Bridge CSAH-15 West of Fergus Falls	20		-0-	--	--		--		-0-		54	
13 reports, 1967-1968		76				5.3		0.38		4,900		--
07-1		51		9.7		2.7		0.43		379		262
Bridge at 4th and Andrews, Bushemridge	--		-0-		2		--		2		30	
46 reports, 1970-1974		70		4.6		5.1		1.75		3,500		--

Source: Minnesota Pollution Control Agency (1975).

Table 7

EE MONITORING STATIONS ON THE OTTERTAIL RIVER

Fecal Coliforms (MPN/100 ml)	TDS (mg/l)	pH	Turbidity (JTU)	Oil (mg/l)	NO_3 (mg/l)	Phosphorus (mg/l)	TSS (mg/l)
200	700	7.5-9.0	25	0.5	45	—	—

Range	Average		Average		Average		Average		Average		Average		Average	
	Percent of Violation	Maximum	Percent of Violation	Range	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation
0		231		7.8		10				0.18		0.07		9	
	8		-0-	7.3-	-0-		-0-	—	—	0.56	-0-		—		—
0				8.2		22						0.14		17	
1		197		7.9		15				0.19		0.14		75	
	54		-0-	7.5-	-0-		8	—	—	0.60	-0-		—		—
0		—		8.2		37						0.20		700	
0		262		8.0		16		1.1		0.123		0.17		42	
	30		-0-	7.2-	-0-		24		100		-0-		—		—
0		—		8.6		52		1.1		0.55		0.57		100	

Near the mouth of the Ottertail River at Breckenridge, turbidity levels were in violation in 24 percent of the samples, and total suspended solids were high. Erosion, either natural or from agricultural lands, may have resulted in this situation. The high nutrient levels were probably caused by domestic or animal wastes, as was the poor microbiological quality. The violations for oil may have been an unusual occurrence or the result of frequent pollution by an oil and grease source(s). The quality of the water was not adequate for its intended uses: drinking water and swimming (Minnesota Pollution Control Agency, 1975).

Sediment and nutrient source types from nonpoint sources were described by the Minnesota Pollution Control Agency (1979) and are presented in Table 8. Although the values may not apply specifically to the Ottertail River within the counties of the subbasin (since no stream was designated), they possibly indicate current conditions in the river. The footnotes at the bottom of the table clarify the symbols and alpha designations used.

Groundwater quality data for seven communities were presented in Table 9 from Winter et al. (1969). No data for manganese, indicated as a problem parameter in the Problems and Needs discussion, were given. Hardness values (275-360 ppm) are typical of the subbasin's groundwater resources, which generally run greater than 200 ppm. The dissolved solid concentrations (354-378 ppm) are characteristic of the shallow sandy deposits of the outwash area; levels occur in the lake plain area on the magnitude of 1,400 ppm.

Aesthetics

Most of the Red River Basin lacks a variety of landscapes. The Ottertail River subbasin, however, particularly in the eastern and central portions, lies in the Minnesota Lake Region and is characterized by many aesthetically pleasing areas. Areas of particular aesthetic appeal include the Tamarac National Wildlife Refuge (42,382 acres) 10 miles north of Detroit Lakes, the White Earth State Forest, which lies in the northeastern section of the subbasin, and Maplewood State Park (92,330 acres), located seven miles east of Pelican Rapids. These sites contain a variety of forests and lake areas and offer residents of the subbasin significant recreational opportunities that are lacking in many areas of the Red River Basin.

Table 8

POSSIBLE SEDIMENT AND NUTRIENT SOURCE TYPES IN THE OTTERTAIL RIVER SUBBASIN

	Water Quality				Sediment					Nutrients		
										Upland[5]		
	Sediment[1]	Nutrient[1]	BOD[1]	Fecal Coliform[1]	Upland Erosion[2]	Streambank Erosion[3]	Drainage Ditch Erosion[3]	Gully Erosion[4]	Wind Erosion[4]	Nitrate	Phosphorus	Feedlots[5]
Clearwater	(+)	+	(+)	-	ML	L (ML-Central)	L	-	+	ML	ML	ML
Clay	-	-	(+)	-	L	ML	M	+	+	L	L	ML
Becker	-	-	(+)	-	ML-H (E)	ML (L-East)	L	-	+	ML	ML	ML
Wilkin	-	-	(-)	-	L	ML	M	+	+	ML	L	ML
Otter Tail	-	-	(-)	-	ML-H	ML (L - Northeast)	L (h)	-	+	ML	ML	ML

[1]Water Quality columns are for informational purposes only.

+'s indicate that water quality measured as in-stream levels of the indicated parameter is better than the median.
-'s indicate worse than the median.
()'s around either sign indicate highly tentative.

It must be emphasized that in-stream levels of potential pollutants can change in a relatively short distance from the site of the monitoring station. Further, only a small number of sampling stations were utilized in the development of these columns. Specifically, considerable extrapolation was utilized to determine the relative quality of water occurring in a respective county.

[2]This indicates the potential for agriculture to adversely affect water quality via soil loss from fields and pastures and delivered to surface waters. These are county average rankings which consider the overall nature of surface waters in the county. Therefore, it can be expected that potentials on a specific stretch of stream or area may deviate from the county potential.

[3]This indicates only the occurrence and relative magnitude of the respective source. This does not indicate the potential to adversely affect water quality.

[4]+'s or -'s indicate the presence or absence of the respective sediment source. This does not indicate magnitude nor water quality impact.

[5]These are preliminary potentials for agriculture to adversely affect water quality by nutrient loss from fields and pastures and from feedlots. The upland ranking considers the nature of the receiving waters and is again a largescale ranking which may differ on a site-specific basis. The feedlot ranking is based solely on estimated numbers of feedlots per township occurring within close proximities to surface waters.

Source: Minnesota Control Agency (1975).

Table 9

GROUNDWATER QUALITY DATA FROM COMMUNITY WATER SUPPLIES IN THE OTTERTAIL RIVER SUBBASIN

		Well Yield		Quality			
Community	Well Depth (Feet)	Operating Rate (gpm)	Estimated Maximum Yield (gpm)	Total Hardness (ppm)	Dissolved Solids (ppm)	Fe (ppm)	Treatment
Detroit Lakes	245	500	1,500+				
	232	500	1,300+	302	378	0.2	
	235	500	1,300				
Perham	100	255	345	294	354	0.02	Fluoridation
	121	500	1,200				
Pelican Rapids	109	200	350				
	118	50	450				
	115	150	600	360		2.6	
	119	250	450	310		0.92	
	420	200-300	500				
Frazee	150	300	500	317	367	3.1	
	88	325	325	360		0.42	
Henning	87	100		290		1.3	
	85	250					
New York Mills	125	90		323	354	3.0	
	125	130	400				
Battle Lake	122	30	250				
	71	300	350	275	356	0.02	

Source: Winter et al. (1969).

Cultural Elements

As Glacial Lake Agassiz receded, numerous depressions and lakes were formed that provided ideal conditions for prehistoric settlement. The Minnesota Man found near Pelican Rapids is generally considered the earliest indication of man in the Red River Valley (Johnson 162:159). To date, 97 archeological sites have been recorded within the subbasin, the majority (75) of which have woodland components. Woodland sites generally receive better coverage because of prominent surface visibility (i.e., mounds). Similar mounds in nearby eastern North Dakota may be correlated with the migration of Siouan tribes from west-central Minnesota (Wedel 1961:224-225). Historical and archeological evidence indicates that Siouan-speakers, notably the Dakota Indians, moved periodically along a migration route that probably transected the subbasin. Natives to Minnesota, the Sioux Indians fought bitterly against the Chippewa invasion of central Minnesota. In 1825 a boundary was established between the two warring tribes by agents of the U.S. government. Legally, it appears that the Sioux controlled most of the subbasin.

The boundary between the Sioux and the Chippewa was later important in negotiating the 1837 Indian land cessions that opened the western half of the state to white settlement (Blegen 1963:128-129). Euro-Americans of predominantly Scandinavian descent colonized the area by the middle of the 19th century. The town of Clitherall, just outside the subbasin boundary, was the first permanent white settlement in Ottertail County (Minnesota Outdoor Atlas, 1979:205). Rumors of pre-columbian runestones and Norsemen flavor the area's history (Milligan, 1968), but irrefutable evidence of European-American culture in the subbasin is to be found in its wealth of recorded historical sites. Four are listed on the National Register of Historic Places, one is listed on the State Historic Site Registry, and 42 have been inventoried.

Recreational Resources

Recreational resources are abundant within the subbasin. The major recreational areas include Maplewood State Park (92,330 acres), a portion of the Tamarac National Wildlife Refuge (42,382 acres), and a portion of

White Earth State Forest (54,400 total acres). The location of these sites is illustrated in Figure III. An inventory of facilities at Maplewood State Park and other recreational areas over 15 acres in the subbasin is included in Appendix B of this report.

The lakes in the subbasin are among the most heavily used for recreational purposes in the upper midwest. Fishing, swimming, boating and water-skiing are popular sports. The distribution of fish species corresponds to the area's geological features. Lakes underlain by sand and gravel, such as those in the vicinity of Detroit Lakes, are populated mainly by walleye. These are some of the most popular lakes in the region. Bass and panfish are common in lakes underlain by glacial till located in the prairie and woodland sections of the subbasin.

The lake areas have attracted many privately owned resorts, which account for approximately 7,204 acres of recreational land and vary in size from 0.5 to 1,649 acres. There are 89 areas comprising 438 acres of state-owned or administered lands (excluding Maplewood State Park and White Earth State Forest) that provide a variety of recreational activities. Hunting and bird-watching opportunities are provided by 22 state wildlife management areas totalling approximately 11,173 acres. Pheasants, deer, geese, and ducks are present within the areas. Furbearing animals include mink, muskrat, fox, and raccoon. In addition, there are many waterfowl production areas, which are open to public hunting.

The Ottertail River is used for canoeing during the summer and fall months, until late September and October when the water level is too low. The section of the river in the western portion of the subbasin is limited for canoeing purposes by water pollution, which detracts from aesthetic quality.

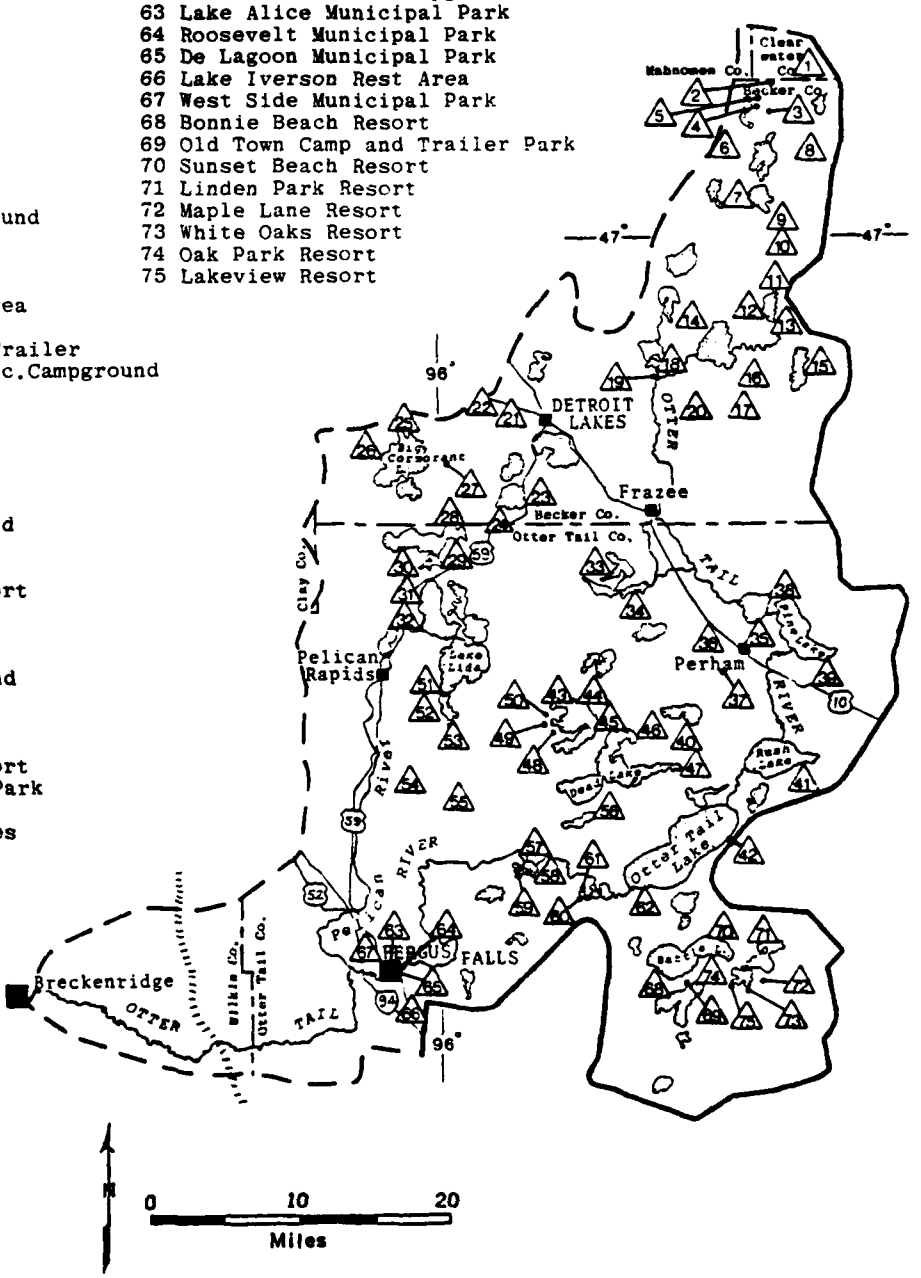
Outdoor winter sports include snow-skiing, cross-country skiing, and snowmobiling, which is growing in popularity.

The major cities and towns have a variety of municipal parks and school athletic fields that provide residents with a variety of non-water based recreational activities.

The majority of recreational sites within the subbasin are under 15 acres; however, areas over 15 acres comprise 95 percent of the subbasin's

△ EXISTING RECREATIONAL AREAS

1 Hoot Owl Resort
2 Ox Bow Resort
3 Pike Lake Resort and Campground
4 Jolly Fisherman Resort
5 R and R Resort
6 Rainbow Resort
7 Tamarac Resort
8 White Earth State Forest
9 Ice Cracking Lodge
10 Happy Hunting Campground
11 Holm's Hide-a-Way Resort
12 Ray's Resort
13 Valhalla Resort
14 Camp Tamarac Group Camp
15 Bambi Resort
16 Little Toad Lake Campground
17 Birchmere Resort
18 Pine Cone Camp Resort
19 Snyder's Resort
20 Detroit Minnesota Ski Area
21 Lakecrest Resort
22 Long Lake Campsite and Trailer
23 Meadow Lake Campsite, Inc.Campground
24 Riverside Place Resort
25 Camp Tee Pee
26 Viking Bay Resort
27 Cormorant Inn Resort
28 Fair Mills Resort
29 Strom's Resort
30 Camper's Point Campground
31 Dunn's Lodge
32 Bo's Resort
33 Stender's Rose Lake Resort
34 Sunset Bay Resort
35 Neudeck's Resort
36 Lakeside Municipal Park
37 Perham Municipal Park and Recreation Area
38 Jungle Shores Resort
39 Koehler's Resort
40 Cal's Rainbow Point Resort
41 Rush Lake Tent-Trailer Park
42 Simmon's Resort
43 East Silent Lake Cottages
44 Wildwood Resort
45 North Star Resort
46 Whitehaven Resort
47 Sunrise Resort
48 Spruce Lodge Resort
49 Deer Trail Lodge
50 Kingswood Resort
51 Maple Beach Resort
52 Cross Point Resort
53 Maplewood State Park
54 Wee Villa Resort
55 Jewett Lake Resort
56 Twin Lake Landing
57 Maple Leaf Resort
58 Weslake Resort
59 Twin Pine Resort
60 Shady Ray Resort
61 Whispering Waters Resort
62 Otter Tail Lake Campground
63 Lake Alice Municipal Park
64 Roosevelt Municipal Park
65 De Lagoon Municipal Park
66 Lake Iverson Rest Area
67 West Side Municipal Park
68 Bonnie Beach Resort
69 Old Town Camp and Trailer Park
70 Sunset Beach Resort
71 Linden Park Resort
72 Maple Lane Resort
73 White Oaks Resort
74 Oak Park Resort
75 Lakeview Resort



Source: Gulf South Research Institute.

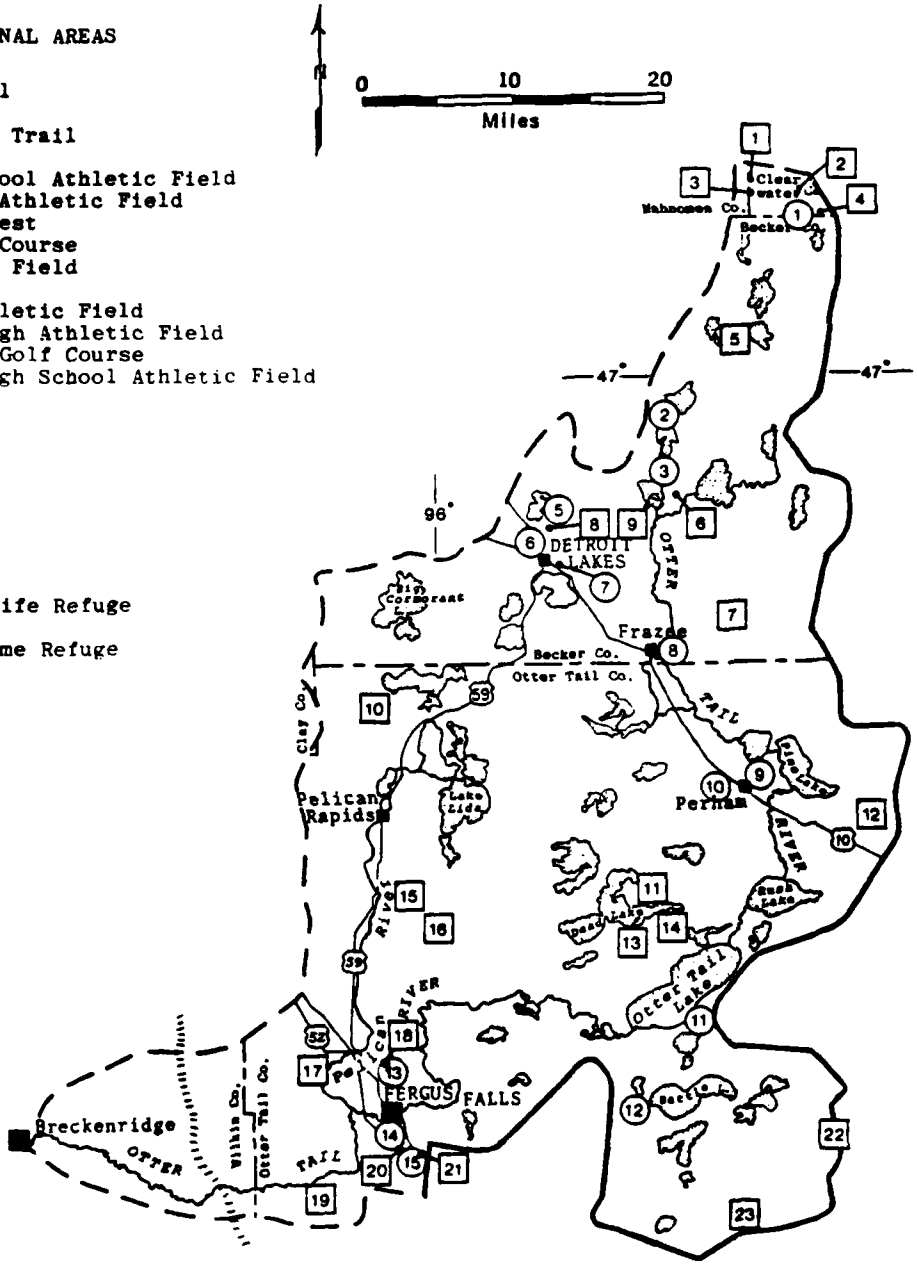
Figure III. RECREATIONAL RESOURCES

○ OTHER EXISTING RECREATIONAL AREAS

1 Height of Land Trail
2 Old Indian Hiking Trail
3 Pine Lake Ski Trail
4 Winter Wonderland Snow Trail
5 Ironman Golf Course
6 Detroit Lakes High School Athletic Field
7 Detroit Lakes Vo-Tech Athletic Field
8 Frazee High School Forest
9 Perham Municipal Golf Course
10 Perham School Athletic Field
11 Balmoral Golf Course
12 Battle Lake School Athletic Field
13 Fergus Falls Senoir High Athletic Field
14 Pebble Lake Municipal Golf Course
15 Fergus Falls Junior High School Athletic Field

□ EXISTING WILDLIFE AREAS

1 Clearwater 23-WMA
2 Clearwater 24-WMA
3 Clearwater 25-WMA
4 Clearwater 26-WMA
5 Tamarac National Wildlife Refuge
6 Hubbel Pond WMA
7 Silverleaf Township Game Refuge
8 Frank WMA
9 PikerelWMA
10 Scrambler WMA
11 Deadlake WMA
12 Homestead
13 Amor WMA
14 Davies WMA
15 Erhard's WMA
16 Colman WMA
17 Haarstick
18 Fergus Falls WMA
19 Orwell WMA
20 Valdine WMA
21 Hi-view WMA
22 Sixteen WMA
23 Inspiration WMA



Source: Gulf South Research Institute.

Figure III. RECREATIONAL RESOURCES (Cont'd)

total recreational acreage. Acreage figures for Maplewood State Park, Tamarac National Wildlife Refuge, and White Earth State Forest are not included in total acreage figures.

Significant Environmental Elements

Social

Detroit Lakes, Fergus Falls, Perham, and Pelican Rapids are the population centers of the subbasin. The cities are located in the upland area and, for the most part, are not subject to flooding problems. Fergus Falls, however, has participated in the Governor's program to build ring dikes. Orwell Dam, constructed in 1953 to alleviate flooding problems in the valley, is located six miles downstream from Fergus Falls. Flooding problems mainly affect the agricultural areas in the valley between Fergus Falls and Breckenridge and result in the loss of soils, damage to crops and equipment, and delays in planting.

Because of the recreational appeal of the subbasin and the increase in lakeshore development in the area, there has been an influx of seasonal residents that places a strain on local services for housing, water, sewer, transportation, fire protection, and law enforcement. Lack of adequate sewage treatment facilities and proper construction codes to prevent erosion and water pollution are areas of particular social concern with respect to environmental features.

Cultural

Ninety-seven archeological sites and 42 historical sites have been recorded in the subbasin, the majority of which are located in the lakes region. Most of the inventoried archeological resources have woodland components with visible surface features (i.e., mounds). Systematic surveys along the Ottertail River might well detect many heretofore unreported sites.

Soils

The quality of soils in the area contributes to the types of crops that can be grown and to the distribution of natural vegetation, as well as determining, to some degree, the suitability of certain areas for contruction or recreation purposes. Soils in the subbasin vary from nearly level to

steep soils formed in lacustrine clay and water modified loam or sand and gravel layers overlying glacial till. The clay areas, found primarily in the western portion of the subbasin, are subject to wind erosion when left unprotected during the winter and early spring. The eastern and central sand and gravel areas are subject to sheet erosion. The main soil management concerns are erosion, wetness, droughtiness, and maintaining fertility and tilth. Soil management practices affect the quality of the numerous marshes, potholes, and large lakes that are valuable wildlife and recreation resources.

Water

Although the subbasin does not have a large number of streams, there are many thousands of lakes that cause surface water areas to occupy nearly 14 percent of the total land area. This is the highest proportion of water acreage for any subbasin in the Red River Basin. The lakes are important for recreation, water supply, and fish and wildlife.

Woodlands

Woodlands or forested areas of the subbasin are important habitats for wildlife because they provide breeding, nesting, resting, and feeding areas and migratory or travel corridors in riparian lands. The Minnesota Land Management Information Service (MLMIS) provides data which indicate that of the 1,251,280 acres in the subbasin, approximately 24 percent is forested. Table 10 gives the percentage figures for woodlands (by subbasin county) in 1969 and 1977 and the percent increase or decrease. Increases can be noted in every county except Mahnomen County. These increases are probably the result of increased numbers of planted shelter belts and windbreaks and reestablishment of vegetation in the lower reaches of streams where flooding has prevented cultivation for agricultural crops (U.S. Fish and Wildlife Service, 1980).

Wetlands

Wetlands are considered significant because of their importance as waterfowl production areas, habitats for flora and fauna, and many other uses such as flood control, nutrient entrapment, groundwater recharge,

Table 10

COMPARISON OF COUNTY PERCENTAGES OF WOODLAND VEGETATION BETWEEN 1969 AND 1977

County	Percentage of County Containing Woodland Vegetation 1969	1977	Change in Percent Composition
Mahnomen	33.4	32.5	-0.9
Clay	2.8	3.0	+0.2
Clearwater	60.2	61.9	+1.7
Becker	40.6	46.5	+5.9
Wilkin	0.6	0.7	+0.1
Ottertail	16.4	19.9	+3.5

Source: Minnesota Land Management Information Service (in U.S. Fish and Wildlife Service, 1980).

etc. Data from the MLMIS show that marshes occupy 27,880 acres, or 2.2 percent, of the total area of the subbasin. Table 11 presents 1964 wetland data for Types 1-5 in Mahnomen, Clay, Becker, Wilkin, and Ottertail counties (data is not available for Clearwater County). The 1964 data represents a 25 percent sampling. All numbers except for Type One have been multiplied by four to give 100 percent values for numbers and acreages of wetlands. Type One wetlands were not measured in the 1964 survey; however, previous studies have indicated that they comprise about 10-15 percent of total wetland acres and 60 percent of total wetland numbers in the Prairie Pothole Region. This information was used to calculate Type One estimates. The 1964 data (expanded to 100 percent) is a conservative estimate.

Table 12 shows wetland numbers and acreages for 1974; this sampling represented a 100 percent inventory. In addition to the wetland types surveyed in the 1964 investigation, exclusive of Type One wetlands, Types Six and Seven and stockponds are included. Table 13 shows a comparison of the 1964 and 1974 wetland inventory data for Types Three, Four, and Five. These data are comparable, since methods used in the 1974 survey allowed direct comparison of the same sampling locations at the 25 percent level sampling. These data show that wetland number and acreages in 1974 have been reduced by 7,255 and 9,394 acres, repectively, from 1964 totals (based on values multiplied to 100 percent from a 25 percent sampling).

Waterfowl Production Areas

Numerous Federal Waterfowl Production Areas (WPA's) are located within the Ottertail River Subbasin. These are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These WPA's are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as provide valuable habitat for migratory waterfowl and many other forms of wildlife. The USFWS is responsible for the compatibility determinations (uses) and the issuance or denial of permits involving these lands. The approximate locations

Table 11

1964 WETLAND INVENTORY DATA FOR FIVE OF THE SIX COUNTIES IN THE OTTERTAIL RIVER SUBBASIN

	Wetland Types [a]									
	1		3		4		5		Total	
County	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Mahnomen	1,848	2,319	2,776	10,975	186	1,973	118	2,509	4,928	17,776
Clay	1,574	1,411	1,881	3,687	567	3,548	176	2,169	4,198	10,815
Becker	1,207	1,332	1,748	5,174	180	2,779	84	924	3,219	10,209
Wilkin	166	506	241	1,187	32	2,058	4	125	443	3,876
Ottertail	7,025	6,656	9,218	18,710	1,434	12,193	1,057	13,469	18,734	51,028
TOTAL	11,820	12,224	15,864	39,733	2,399	22,551	1,439	19,196	31,522	93,704

[a]Type 1-Seasonally flooded basins or flats
Type 2-Fresh Meadows
Type 3-Shallow fresh marshes
Type 4-Deep fresh marshes
Type 5-Open fresh water

[b]Calculated at 60% of total wetland numbers.

[c]Calculated at 15% of total wetland acres.

Source: U.S. Fish and Wildlife Service, 1980.

Table 12

1974 WETLAND INVENTORY DATA FOR FIVE OF THE SIX COUNTIES IN THE OTTERTAIL RIVER SUBBASIN

	Wetland Type															
	3		4		5		6		7		8		Stock Ponds		Total	
County	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Mahnomen	1,504	9,919	261	5,054	130	9,206	46	477	2	25	--	--	144	--	2,087	24,681
Clay	1,299	7,338	311	3,671	158	5,652	393	7,249	61	673	--	--	165	--	2,387	24,583
Becker	1,688	15,520	210	9,700	103	12,843	87	1,935	--	--	--	--	37	--	2,125	39,998
Wilkin	108	3,614	15	218	3	177	9	28	--	--	--	--	32	5	167	4,042
Ottertail	4,127	16,217	2,110	20,275	1,251	31,128	1,877	11,986	23	408	9	153	288	33	9,685	80,200
TOTAL	8,726	52,608	2,907	38,918	1,645	59,006	2,412	21,675	86	1,106	9	153	666	38	16,451	173,504

Source: U.S. Fish and Wildlife Service, 1980.

Table 13

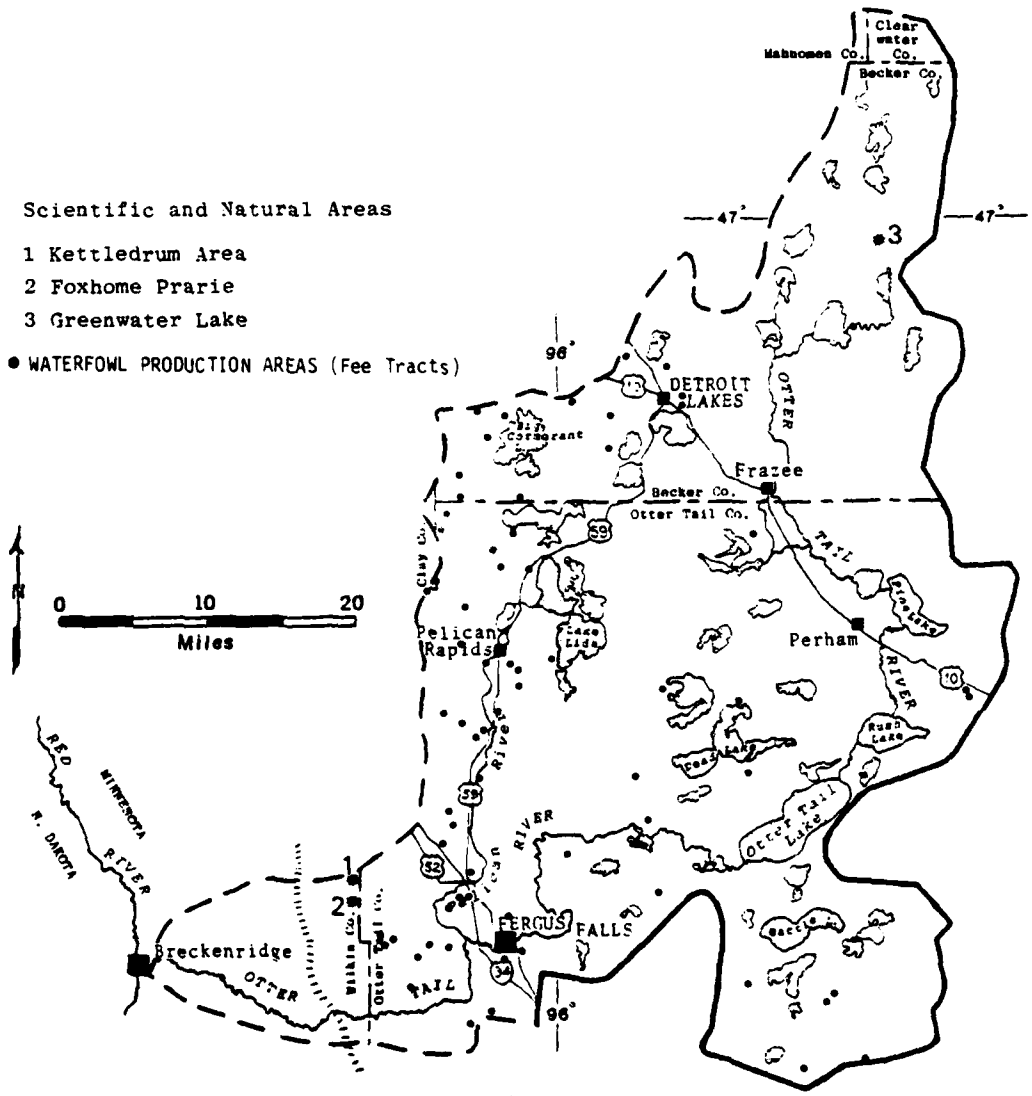
COMPARISON OF 1964 and 1974 WETLAND INVENTORY SHOWING NUMBER, ACREAGE, AND PERCENT CHANGES FOR COUNTIES IN THE OTTERTAIL RIVER SUBBASIN[a]

	Wetland Types															
	3				4				5				Total			
County	Number	Percent	Acre	Percent	Number	Percent	Acre	Percent	Number	Percent	Acre	Percent	Number	Percent	Acre	Percent
Mahnomen	-830	-29.9	-3136	-28.6	-66	-35.5	+291	+14.7	-88	-74.6	-1596	-63.6	-984	-31.9	-4441	-28.7
Clay	-418	-22.2	+472	+12.8	-300	-52.9	-1154	-32.5	-60	-34.1	-400	-18.4	-778	-29.6	-1082	-11.5
Becker	-844	-48.3	-217	-4.2	-120	-66.7	-1246	-44.8	-72	-85.7	-384	-41.6	-1036	-51.5	-1847	-20.8
Wilkin	-147	-61.0	-337	-28.3	-5	-15.6	+516	+25.0	--	--	-61	-48.8	-152	-54.9	+117	+3.4
Ottertail	-5,094	-55.3	-3676	-19.6	+801	+55.9	+1264	+10.3	-12	-1.1	+270	+2.0	-4305	-36.8	-2143	-4.8
TOTAL	-7,333		-6894		+310		-329		-232		-2171		-7255		-9394	

[a]Represents values multiplied to 100 percent from a 25 percent sample.

Source: U.S Fish and Wildlife Service, 1980.

of these WPA's (fee tracts) within the subbasin are shown in Figure IV. Total acreage of these WPA's (fee and easement) within Mahnomen, Clay, Becker, Wilkin, and Ottertail counties are given in Table 14.



Source: The Nature Conservacy (no date); Miles and Yaeger (1979); U.S. Fish and Wildlife Service (1980).

Figure IV. WATERFOWL PRODUCTION AREAS AND SCIENTIFIC AND NATURAL AREAS WITHIN THE OTTERTAIL RIVER SUBBASIN

Table 14

ACRES OF FEDERAL WATERFOWL PRODUCTION AREAS
(FEES AND EASEMENT) IN FIVE OF THE SIX COUNTIES
OF THE OTTERTAIL RIVER SUBBASIN

County	Purchased Acres	Easement (Acres)	Total Acres
Mahnomen	4,520	4,262	8,782
Clay	7,063	1,330	8,393
Becker	9,458	463	9,921
Wilkin	1,247	167	1,414
Ottertail	15,265	5,365	20,630
TOTAL	37,553	11,587	49,140

Source: Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service as of September 30, 1978. U.S. Department of the Interior, Division of Realty, Washington, D.C.

Wildlife Management Areas

A total of 23 wildlife management areas or refuges are found within the subbasin. A list of these areas and their acreages and location were presented in the existing conditions section for recreation. These areas are considered significant because of the opportunities provided for outdoor recreation and the protection and management given to biological resources within their confines.

Threatened or Endangered Species

Threatened or endangered species found, or possibly occurring, in the subbasin are the arctic peregrine falcon and bald eagle. Although the falcon is not known to breed in the area, its wintering range is located throughout the subbasin. The nesting range for the bald eagle include those portions of Becker, Mahnomen, and Clearwater counties within the subbasin. The Dakota Skipper butterfly, a proposed endangered species, may occur in the subbasin, particularly in the two relict prairies (Figure IV) in Wilkin County (U.S. Fish and Wildlife Service, 1979; McCabe and Post, 1977).

Other Important Species

The Minnesota Department of Natural Resources identified certain animals in need of special consideration, those of special interest, and priority species; these faunal species are discussed below.

Those species in need of special consideration consist of the following: (1) burrowing owl, greater sandhill crane, and greater prairie chicken--threatened; (2) northern bald eagle, marsh hawk, common tern, and western grebe—changing or uncertain status; (3) bobcat, great blue heron, pileated woodpecker, and snapping turtle--special interest (Moyle, 1974). The burrowing owl may occur in the subbasin, especially in prairie remnants such as the two locations in Wilkin County. Summer resident sightings have been made of the sandhill crane near Frazee in the 1977-78 survey period. The greater prairie chicken occurs in the western portion of the subbasin along the beachlines (based on 1978 booming ground reports). The eagle was discussed earlier for Federal threatened or endangered species. The marsh hawk and pileated woodpecker are known to breed in the region (Region 1S) that includes the subbasin.

Colonial bird nesting sites are known for the common tern at Cotton Lake, western grebe at Orwell Reservoir, and great blue heron at Franklin, Dead, and Star lakes in the subbasin. A total of eight, four, and one bobcats were harvested from Becker, Clearwater, and Ottertail counties, respectively, in the 1978-79 trapping season, indicating that this species probably occurs in the subbasin. The snapping turtle has been reported from Becker County, which is included by the subbasin limits (Henderson, 1978a and b, 1979; Mann, 1979; U.S. Fish and Wildlife Service, 1980).

Species of special interest occurring in the counties of the subbasin include the western smooth green snake, Canadian toad, and Great Plains toad. The smooth green snake is restricted to habitats consisting of moist grassy areas of plains and meadows (Conant, 1975). The two toads are western amphibians found on the eastern limits of their range in the state; also, additional information is needed on the Great Plains toad (Henderson 1979).

Mammals that have been designated as priority species by Henderson (1979) include the Arctic shrew (Ottertail County), starnosed mole (Becker

County), porcupine (Becker County), and the northern grasshopper mouse (Ottertail and Clay counties). The shrew, mole, and porcupine are northern species found in the southern limits of their range, and the mouse is a western species occurring on the eastern edge of its range in the state.

Natural Areas

Three natural areas occur in the Ottertail River subbasin: Kettledrum Prairie, Foxhome Prairie, and Greenwater Lake (Figure IV). Kettledrum Prairie, found in Wilkin County, comprises an area of 200 acres along the highest beach ridge of glacial Lake Agassiz. It is an excellent native grassland with abundant prairie dwelling flora and fauna. Foxhome Prairie, also located in Wilkin County, is composed of 240 acres of tallgrass prairie. Characteristic flora at the site include big and little bluestem, Indian grass, switch grass, and dropseed. Migrating waterfowl utilize the wet sedge pockets and open water marsh. Significant features of Greenwater Lake, a nominated site for DNR Scientific and Natural Areas, include a 724-acre lake with a unique clarity of water and a potential as a research area for the Fresh Water Biological Institute and others (The Nature Conservancy, no date; Minnesota Department of Natural Resources Scientifc and Natural Areas Files, July 1977).

In addition to the significant elements described above, the Ottertail River itself is considered important because of its clear waters, many lakes, and wild rice marshes and the abundant fauna that are associated with the variety of habitats in the middle and headwaters region of the stream (U.S. Fish and Wildlife Service, 1979).

V. FUTURE CONDITIONS

V. FUTURE CONDITIONS

The "most probable" and "without project" future conditions and resources of the subbasin are presented below. This discussion centers on economic features, population projections, and likely environmental aspects.

Most Probable Economic Conditions

Initial consideration was given to the utilization of all OBERS Series E and E' projections of general economic and demographic indicators for the non-SMSA portion of the Fargo-Moorhead Metropolitan area. Recent trends, however, indicate that the OBERS figures are an underestimation, since OBERS projects steady decreases throughout the study period. Becker and Ottertail counties, the principal components of the subbasin, have been experiencing an increase in population in the last decade. For this reason, state, regional, and GSRI developed projections have been designated as most probable for population and employment statistics. OBERS E and E' per capita income and future agricultural activity projections were, however, deemed adequate for the purposes of this study.

Table 15 presents population, employment, and per capita income (expressed in 1979 dollars) figures for the subbasin.

These figures reflect the growth of communities such as Fergus Falls and Detroit Lakes, which will continue to expand their area of influence and will affect growth in nearby towns and rural areas. Industrial and related growth is anticipated in conjunction with the development of industrial parks and sites in both cities. Amenity related developments are also expected to influence growth in the study area, particularly in the vicinity of the recreational lakes and other tourist centers.

The West Central Regional Development Commission has designated Becker and Ottertail counties as redevelopment areas, with Detroit Lakes and Fergus Falls as development centers in the region. In their estimation, the economic development potential for Detroit Lakes and environs lies in tourism and light industry, whereas Fergus Falls has its greatest potential in retail trade, light industry, and agricultural processing. It is also felt that the subbasin will be considerably influenced by developments in the Fargo-Moorhead area.

Table 15

OTTERTAIL RIVER SUBBASIN POPULATION, EMPLOYMENT AND PER CAPITA INCOME PROJECTIONS 1990-2030

Parameter	Year 1970	1977	1980	1990	2000	2010	2020	2030
Population	47,400	51,494	53,000	58,000	63,000	67,000	71,000	75,000
Employment	18,012	23,172	24,000	25,500	27,700	29,500	31,200	33,000
Per Capita Income (1979 Dollars)	$ 4,575	$ 5,867	$ 9,100	$12,300	$16,600	$22,400	$30,300	$40,800

Sources: U.S. Water Resources Council, 1972 OBERS Projections, Series E; West Central (Minnesota) Regional Development Commission; and Gulf South Research Institute.

Most Probable Agricultural Conditions

Roughly 553,000 acres within the subbasin are currently under cultivation, and hay, wheat, corn, and oats are the four principal crops. The estimated value of production in 1980 of these principal crops (using October 1979 Current Normalized Prices for Minnesota) is $47.1 million. Projections of total production through 2030 for the principal crops grown in the subbasin are presented in Table 16. The projected total production for 2030 represents a value of $79.1 million (using October 1979 Current Normalized Prices for Minnesota).

Table 16

OTTERTAIL RIVER SUBBASIN PRINCIPAL CROPS AND PROJECTED PRODUCTION, 1980-2030 (Production in Thousands)

Year	Crop Hay (Tons)	Wheat (Bushels)	Corn (Bushels)	Oats (Bushels)
1980	310	3,308	7,717	5,707
1990	360	3,837	8,951	6,620
2000	409	4,367	10,186	7,533
2010	440	4,697	10,958	8,104
2020	471	5,028	11,730	8,675
2030	521	5,557	12,965	9,588

Sources: OBERS Series E'; and Gulf South Research Institute.

Table 17

OTTERTAIL RIVER SUBBASIN, SUMMARY OF PRESENT AND FUTURE AVERAGE ANNUAL DAMAGES
URBAN, AGRICULTURAL, AND TRANSPORTATION
(October, 1979 Prices, 7 1/8 Percent Interest)

	Flood Damages									
Category	1980	1990	2000	2010	2020	2030	Increase 1980-2030	Average Annual Equivalency Factor	Average Annual Equivalency of Increase	Equivalency Average Annual Damages
Urban	2,600	2,900	3,100	3,400	3,600	3,900	1,300	.2903	400	3,000
Agricultural										
Crop	178,700	207,300	235,900	253,800	271,600	300,200	121,500	.2903	35,300	214,000
Other Agricultural	51,600	55,700	59,900	62,400	65,000	69,100	17,500	.2903	5,100	56,700
Transportation	13,000	13,000	13,000	13,000	13,000	13,000	--	--	--	--
TOTAL	245,900	278,900	311,900	332,600	353,200	386,200	140,200	.2903	40,800	286,700

Source: Gulf South Research Institute.

Evaluation of Flood Damages--Future Conditions

A summary of present and future average annual flood damages is presented in Table 17. Assuming a discount rate of 7 1/8 percent, average annual damages throughout the projection period are expected to be $286,700, of which 94 percent is agricultural damages.

Flood damages to residences, businesses, industrial structures, churches, schools, automobiles, house trailers, public property and contents are included in the urban damages category. Damages to streets and utilities (including water, gas electricity, sanitary sewers, storm sewers, and telephone systems) are also taken into consideration. This category also includes loss of wages, loss of profits, expenditures for temporary housing, cleanup costs, and extra expenses for additional fire and police protection and flood relief.

Agricultural flood damages consist of crop and pasture damage, which may include costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other related flood losses.

Other agricultural damages consist of land damage from scour and gully erosion and deposition of flood debris; livestock and poultry losses; damages to machinery and equipment, fences, and farm buildings and contents (excluding residences); and damages to irrigation and drainage facilities.

Transportation damages include all damages to railroads, highways, roads, airports, bridges, culverts, and waterways not included in urban damages. In addition, all added operational costs for railroads and airlines and vehicle detours are included.

Future growth of urban flood damages was estimated to be an uncompounded (straight-line) rate of one percent per year for a 50-year period beginning in the base year, with no growth thereafter.

Agricultural crop flood damages were projected to increase at the same rate as crop income projections published in the 1972 OBERS Series E projection report. These crop income projections were prepared by the U.S. Economic Research Service (ERS) for the Red River of the North region. Other agricultural flood damages were projected to increase at one-half of this rate.

Transportation damages are not expected to change throughout the project life because of the long-term economic life associated with such structures as bridges, railways, roads, and culverts. In addition, it has been found that repairs to these types of strucutures rarely exceed the cost of a new structure even with frequent flooding.

ost Probable Environmental Conditions

The water quality of the Ottertail River, primarily in the lower reaches, should improve with successful implementation of point and nonpoint pollution abatement plans. Nonpoint sources are expected to take considerably longer than point sources to rectify pollution problems. Low flows in the Pelican River and smaller tributaries will continue to cause problems relative to minimum streamflow requirements for recreational usage.

Some increase in woodland habitats for wildlife will occur if land use trends during the period 1969-1977 continue; conversely, wetland data for 1964 and 1974 indicate that these habitats will continue to deteriorate along with associated biota. Aquatic habitats in the lower reaches of the Ottertail River should improve with commensurate improvements in water quality, but low flows in the Pelican River and smaller tributaries of the Ottertail will continue to affect faunal populations.

Without Project Conditions

It is anticipated that the conditions that will prevail over the 50-year planning period in the absence of a plan to alter resource management procedures will be the same as those set forth previously under the most probable future scenario.

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

Institutions

The development of effective water resources management practices in the subbasin is affected by a large number of Federal, state, and local agencies involved in project planning and implementation. There are 44 Federal agencies with various types of jurisdictions, and 14 directly involved in the water and related land resource planning process. At the state level, 27 agencies are involved. There are also regional commissions, county agencies, and municipal entities. Differences in perspective and problems of coordination hamper the effective and speedy resolution of problems.

The Ottertail River subbasin is aided in water resources development by the inclusion of the area in two small but organized watershed districts (Pelican and Cormorant lakes). There are also five soil and water conservation districts that have jurisdiction within the subbasin, including those representing Mahnomen, Clearwater, Becker, Ottertail, and Wilkin counties. The Corps of Engineers constructed Orwell Dam within the subbasin for flood control purposes in 1953, but the Soil Conservation Service has not developed any projects in the area. The Corps of Engineers, the Pelican River and Cormorant Lakes Watershed Districts, the Soil Conservation Service, the soil and water conservation districts, and the town of Fergus Falls are the main entities that should be taken into consideration in flood control planning for the subbasin. In devising an effective flood control program, perceptions of the extent to which upland drainage patterns contribute to flooding in the valley are important to the successful resolution of these problems. Therefore, the towns of Detroit Lakes, Fergus Falls, Perham, and Pelican Rapids and the White Earth Reservation Tribal Council, should be consulted. It should be noted that the West Central Regional Development District has developed an overall economic development plan that includes the subbasin area.

Structural Measures

As a result of the drought during the 1930's, 31 dams were constructed in the lake region of the subbasin. These dams, most of which are simple

low-head dams with stoplog controls, maintain the lakes at levels required for recreational activities and water conservation. All dams were completed in 1938. These dams were not intended for flood control, and therefore their effect on flooding is insignificant.

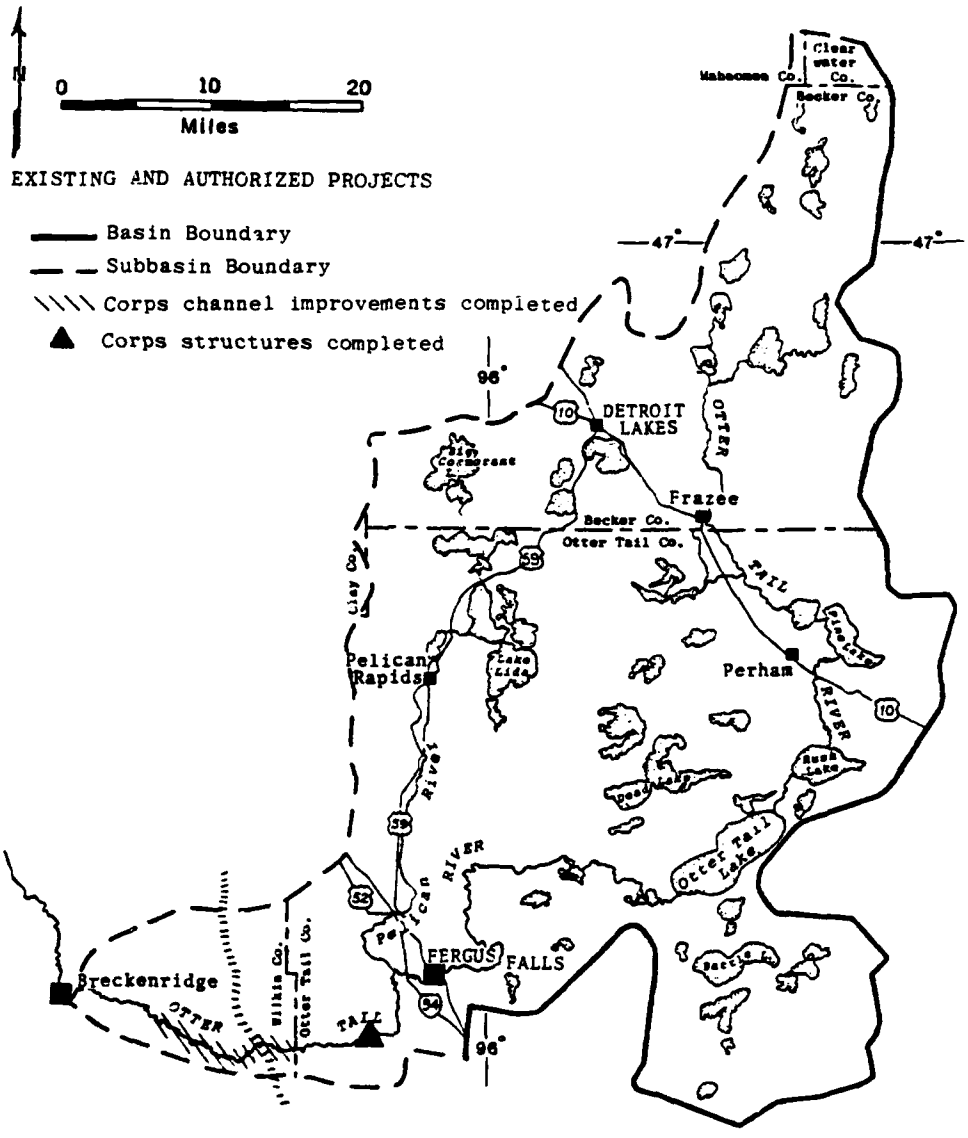
Major flood reduction measures undertaken include the Orwell Reservoir, constructed in 1953, and channel improvements, constructed in 1954 (Figure V). These improvements were constructed under the auspices of the U.S. Army Corps of Engineers. Orwell Dam is situated on the Ottertail River about six miles southwest of Fergus Falls. The reservoir provides an effective storage capacity of 13,100 acre-feet of dual-use storage for flood control and lowflow supplements for water supply and water quality control. Channel improvements consist of about 11.4 miles of straightening, clearing, and enlarging of the Ottertail River from a point about 14 miles below Orwell Dam to a point about three miles east of Breckenridge.

The Soil Conservation Service has not constructed any projects in the area and has not received any applications for planning assistance. The Pelican Lakes Watershed District appears to be inactive, but the Cormorant Lakes Watershed District is actively engaged in planning efforts that would lead to the reduction of flooding in the immediate vicinity of Big Cormorant Lake. No other water resource planning activities are presently taking place in the subbasin that would lead to a reduction in flooding problems.

Nonstructural Measures

Nonstructural flood control measures are measures that reduce or eliminate flood damages through procedures that involve little, if any, construction efforts. The major types are flood warning, floodplain zoning, flood insurance, flood proofing, and floodplain evacuation. These measures are primarily applicable to urban areas.

Urban flood damages in the subbasin are small, and it is apparent that most of the urban damages in the upland portions of the subbasin are due to water collecting in lakes and depressed areas rather than to streambank overflow. Even though the urban damages are small, Detroit Lakes, Fergus Falls, Ottertail, and Thief River Falls and Wilkin, Ottertail, and Becker counties all participate in the Federal flood insurance program.



Source: Gulf South Research Institute.

Figure V. Existing Flood Control Measures

All these towns participate in the Red River Valley flood warning system. The flood warning system for the Red River Valley is a cooperative network organized by the National Weather Service in Fargo, North Dakota. Fifty volunteers throughout the basin report to the National Weather Service on a weekly basis during winter and fall and on a daily basis during spring and summer. The reportage covers all precipitation of 0.1 inch or more, including amount of snow and water equivalent. This information is transmitted to the River Forecast Center in Minneapolis, where it is run through a computer system to determine probable flood stages. The predicitons are then transmitted to the National Weather Service in Fargo, which releases them to the public through the news media. Communities are then able to engage in emergency actions to protect themselves from flood damages. Contacts with local officials indicate that the flood warning system generally works quite well in the subbasin.

There are other types of measures that could be used in the subbasin to reduce flood damages but that are not directly applicable to urban areas. These measures would include such things as land treatment programs, use of present drainage ditches for floodwater storage, better use of present control structures to regulate water levels in lakes, use of natural areas for water retention, and acquisition of previously drained natural areas for reversion to water retention use. Land treatment is used by some farmers in the subbasin, but the SCS has not been called upon to undertake a large-scale program. Present drainage ditches are not used for floodwater storage, and no plans have been developed for future use. Information on natural storage areas and potentialities for increased storage is not available. The potentialities for use of present control structures on lakes to regulate water flows downstream cannot be determined at present because of a lack of information on their present capacities and functions.

Adequacy of Existing Measures

Probable frequencies of the maximum annual mean daily flows based on data through 1947 were the bases of design for Orwell Dam and the channel improvements constructed in the 1950's. An update of the frequencies for various flood peak flows through 1969 shows considerable increase in flow rates. Channel capacity at a point 14 miles downstream from

Orwell Dam was designed for a flow of 1205 cfs (cubic feet per second), which represented a 10-year frequency flood. Later flow data indicate the flow for a 10-year frequency flood to be 1570 cfs, or 365 cfs more than the channel design flow. However, according to the design parameters, the channel was to include a freeboard allowance of approximately one foot. A cursory analysis of the channel indicates that it can adequately contain the increased 10-year flood frequency flow within the one-foot freeboard. Since the completion of the channel improvements, subsequent flood damage reports validate this analysis.

Post flood reports for three major floods in 1969, 1978, and 1979 reported no damages in rural areas. Since all these flood exceeded the 10-year frequency flood, it can be concluded that the improved channel can contain a 10-year frequency flood flow.

Further analyses of the unimproved channel of the Ottertail River from Breckenridge Lake to its junction with the Bois De Sioux River also indicate that this reach is capable of containing the 10-year frequency flood flow. Post flood reports also tend to bear out this finding.

Investigation of the Ottertail River relative to a 100-year frequency flood indicates that the flows will exceed the channel banks in the lower reaches. However, as well as could be determined from USGS quadrangle maps, it appears that the maximum extent of flooding would not exceed 1,000 feet on each side of the stream, and this would occur only in a small area. It appears that most flooding from a 100-year frequency flood would occur in a floodplain varying in width from 600 to 1,000 feet. The frequency of this flood and the relatively small area affected by the flood does not warrant extensive channel improvements or levee construction.

The plan of operation of Orwell Reservoir should be reevaluated to compensate for the updated flood-frequency flows. Preliminary design data indicate that the reservoir and dam can adequately store and regulate the updated 10-year frequency flood flow. Further scrutiny should be made to determine to what extent the 100-year frequency flood flow can be regulated to minimize downstream flooding.

VII. CRITERIA AND PLANNING OBJECTIVES

VII. CRITERIA AND PLANNING OBJECTIVES

Floodplain Management Criteria

Technical, economic, and environmental criteria must be considered when formulating and evaluating alternative floodplain management measures for the subbasin.

The technical criteria used in formulating and evaluating alternatives for this report consisted of the application of appropriate Federal engineering standards, regulations, and guidelines.

Economic criteria entailed the identification and comparison of benefits and costs of each measure. Tangible economic benefits must exceed costs; however, in certain instances, considerations of appropriate gains in the other accounts (environmental quality, social well-being and regional development) could alter this requirement. All alternatives considered are scaled to a design which optimizes benefits. Annual costs and benefits are based on an interest rate of 7 1/8 percent and price levels and conditions existing in October 1979. A 50-year amortization schedule is used for the features considered.

Environmental considerations call for the formulation of measures that minimize objectionable or adverse environmental effects and maximize environmental benefits. Also, limited consideration was given to modifications based on coordination with state and Federal agencies, local interests, and citizen groups.

Planning Objectives

The primary planning objective of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood losses. In conjunction with this economic objective, the study attempted to develop contributions to the environmental quality of the subbasin.

The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin. On the basis of the identified problems, needs, and desires, the following planning objectives were established:

(1) Contribute to protection from and prevention, reduction, or compensation of flood losses for the flood prone areas of the subbasin during the period of analysis.

(2) Contribute, to the maximum extent possible, to the preservation of the quality of the existing riverine environment and enhance the environmental potential of the subbasin as a whole.

(3) Contribute to the enhancement of recreational opportunities throughout the subbasin.

(4) Contribute to the improvement of water quality in the lakes and in the Ottertail and Pelican rivers.

(5) Contribute to the improvement of water supply in the upland portion of the subbasin.

(6) Contribute to the reduction of wind and water erosion throughout the subbasin.

(7) Contribute to the developing trend toward increased irrigation throughout the subbasin.

(8) Contribute the reduction of wastewater management problems, particularly insofar as they relate to water quality.

(9) Contribute to the development of small hydroelectric installations in the upland portions of the subbasin and the utilization of Orwell Dam for hydroelectric production.

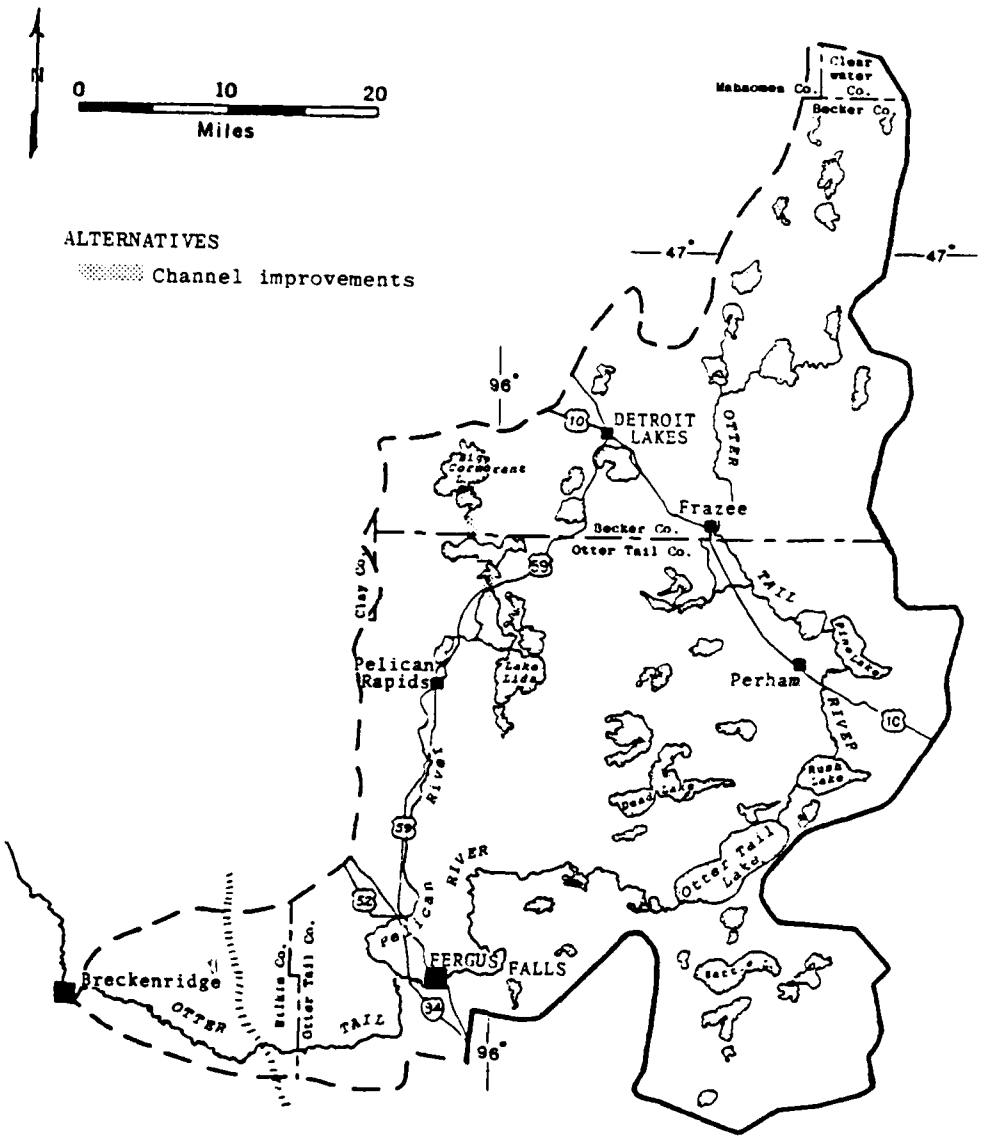
VIII. FORMULATION OF ALTERNATIVE MEASURES

VIII. FORMULATION OF ALTERNATIVE MEASURES

This section contains a discussion of the management measures that have been identified to meet the resource management objectives. In the formulation of measures, prime consideration was given to the resolution of flooding problems caused by stream overflows. However, a consideration of the adequacy of existing measures indicated that the overbank flooding problems of the lower Ottertail River have been taken care of by Corps of Engineers projects that are presently in place. Thus, attention was directed to the upland portion of the subbasin, which contains many thousands of lakes.

In the Big Cormorant Lake area, flooding is becoming an increasing problem. All lakes in this general area ultimately drain into Big Cormorant Lake, which has no outlet. As a result, the water level in Big Cormorant Lake has risen significantly, resulting in property loss, navigation hazards, pollution, and the removal of valuable property from the tax rolls. Left unchecked, the continued rise in the water level of this lake will ultimately result in significant rises in the water levels of all tributary lakes--the ultimate result being property losses and more severe navigational hazards and pollution problems. To counteract this occurrence, control structures at strategic points and channel improvements to transport excess flows will be required (Figure VI). The measure, which could be constructed by the Cormorant Lakes Watershed District, would stabilize water levels in the district and would eliminate flooding on approximately 380 acres of lakefront property.

This constitutes the only flood control alternative that has been developed for the subbasin. However, given the nature of the problem in the Cormorant Lakes area, the many thousands of lakes in the subbasin, and the widespread flooding in upland areas discussed in the third section of this report (and illustrated in Figure II), it is probable that conditions similar to those in the Cormorant Lakes area are prevalent throughout the upland portions of the subbasin. However, no information is available on the exact nature of these problems, so that flood control alternatives for other upland portions of the subbasin cannot be identified at this time.



Source: Gulf South Research Institute.

Figure VI. Alternative Flood Control Measures

Besides these structural measures, there is an opportunity for the implementation of nonstructural measures in the subbasin. According to available information, none of the cities in the subbasin that participate in the Federal flood insurance program have floodplain zoning ordinances. This may be due to the absence of overbank flooding in these towns. However, if overbank flooding is a problem, floodplain zoning ordinances should be instituted.

There is an opportunity for the use of land treatment measures throughout the subbasin that would help to contain water on land as well as reducing flood and erosion damages and improving water quality. Natural retention areas should also be considered for preservation. However, these would need to be located, and their potential for flood damage reduction would need to be identified. The use for flood control of present water-level control structures on lakes should be investigated. Flood proofing and relocation should also be considered. In addition, the plan of operation of Orwell Reservoir should be reevaluated.

It should be noted that the city of Breckenridge was not covered in this report. Breckenridge is affected by floods from the Ottertail River, but it is located at the confluence of the Ottertail and Bois de Sioux rivers, which join to form the Red River of the North. Alternatives are available to solve the flood damage problems at Breckenridge, but these will be covered in the Main Stem Subbasin report.

IX. ASSESSMENT OF ALTERNATIVES

IX. ASSESSMENT OF ALTERNATIVES

Economic Assessment

The effects of the flood control alternative for the subbasin along with its costs and benefits are presented in Table 18.

Available exceedence-frequency-discharge area curves from this basin were used to construct drainage area versus discharge to curves for 1, 10, 30, and 50 percent frequency floods. Cross-sectional data from previous engineering reports on channel improvements were used as the basis for calculating floodplain areas. A delineation of flood prone areas around Cormorant Lake was taken from mapping presented in the Overall Plan for the Cormorant Lakes Watershed District. Capital costs for the alternative were calculated by using October 1979 unit construction costs.

Flooding problems around Big Cormorant Lake are the result of water accumulations in a lake with no outlet. Prior to residential development of the surrounding lakeshore property, years of below normal rainfall lowered the water level in the lake. Substantial residential development occurred on the land between the lake's original perimeter and the new, smaller perimeter. As rainfall levels returned to normal, the lake began to rise, inundating many residential units. The number of residential units affected is unknown, and no damage estimates are available. Thus, no average annual benefits can be developed with any degree of certainty, and flood control measures to alleviate this problem cannot be properly evaluated.

Telephone conversations with a Cormorant Watershed District official revealed that as many as 500 cottages and homes valued between $30,000 and $60,000 were either subject to flooding or threatened by flooding. For purposes of analysis, it was assumed that 80 percent of the estimated average annual urban damages in the subbasin could be applied to the Cormorant Lakes area and claimed as benefits for the flood control alternative. It is recognized that this is not an adequate basis for evaluating the measures and that a detailed analysis of present and potential damages needs to be undertaken in the Cormorant Lakes area.

Table 18

ECONOMIC EVALUATION OF ALTERNATIVES

Alternatives	Control Structure and Channelization
Average Annual Acres	380
Capital Costs	822
Average Annual Costs	61
Average Annual Rural Benefits	--
Average Annual Urban Benefits	2.0
Average Annual Benefits	2.0
Total Average Annual Benefits	2.0
B/C Ratio (Percent)	0.03

Source: Gulf South Research Institute.

Impact Assessment

Control structures and channel improvements in the Big Cormorant Lake area are the measures recommened for consideration in the Ottertail subbasin. These improvements would result in moderately beneficial economic and social effects, since they would reduce property and tax losses and navigation hazards that have been affecting the area because of flooding. The potential also exists for these rising water levels to affect tributary lakes, which might result in similar problems at these locations.

Minimally beneficial biological and water quality effects would result from decreases in pollution levels and improved water quality. Maximum beneficial recreational effects would stem from reductions in land loss to lakefront properties and improved navigation conditions. No effects would be known to occur to water supply and cultural elements.

Construction of the channels will remove wetlands and riparian habitats in the natural drainages between Big Cormorant Lake and Pelican Lake and between Pelican Lake and Lake Lizzie. Aquatic and terrestrial habitats of lower productivity will be created with these channel improvements.

Implementation of a control structure at the lower end of Big Cormorant Lake, as well as on smaller tributary lakes such as Bejou, Leif, and others, will reduce flooding and maintain more constant water levels. The fisheries of these lakes may be improved with proper management of lake levels. However, it is expected that increased development may be induced around the perimeter of these lakes with the alleviation of significant increases in lake level heights during flood periods. This increased development will further degrade shoreline habitats for both wildlife and aquatic biota. No appreciable effect is expected on Pelican Lake or lower lakes in the system, nor will these measures assist in rectifying problems with low flows to any significant extent in the Pelican River.

The Minnesota Water Resources Board (1967) indicated other problems in the Cormorant chain of lakes: pollution from high bacterial and nutrient levels, increased siltation in the lakes from water and wind erosion on surrounding lands, and navigation problems caused by dead trees and stumps in the lakes. As recognized in their report, stringent enforcement of regulations for septic tanks, out-houses, manure piles, etc. will alleviate many of the problems with bacterial and some of the nutrient pollution.

Improved farming practices in surrounding agricultural lands will help to reduce problems with nutrients from fertilizers and with soil erosion. Although snags and stumps may hamper navigation, the benefits to the environment created by these trees for breeding and spawning sites for aquatic biota, fish attractants, and roosting sites for some wildlife species should be recognized. Increased development around lake perimeters may aggravate these problems, particularly with regard to the assimilative capacity of the lakes as related to water and sediment quality.

Further consideration should be given to possibly restoring wetlands around the Cormorant chain of lakes, since there are indications that wetlands may play a substantial role in controlling runoff, especially in combination with good land treatment practices. Values on storage have averaged about 12 inches per surface-acre of wetlands, and have ranged to four times that amount (Cernohous, 1979). Correlated with this consideration is the protection of existing wetlands, which were reduced by more than 9,000 acres in the counties included by the subbasin during the 10-year period from 1964 to 1974.

X. EVALUATION

X. EVALUATION

National Economic Development (NED) and Environmental Quality (EQ) plans will be tentatively formulated in association with the overall Red River of the North reconnaissance report. Control structures and channel improvements measures are the only alternatives recommended for consideration in this subbasin. The benefit/cost ratio is negligible.

XI. ADDITIONAL STUDY NEEDS

XI. ADDITIONAL STUDY NEEDS

This report was developed almost entirely on the basis of secondary information from readily available planning documents. Data available from state and Federal agencies was not fully canvassed, and only a limited number of calls were made to the area. In particular, state university libraries and departmental resources could not be fully utilized. Thus, the document aims only at a broad-brush perspective. In order to provide a more detailed and in-depth analysis of subbasin resources, problems, and potential solutions, the following additional study needs would have to be fulfilled:

1. Subbasin boundaries need to be better defined on the basis of hydrologic conditions, and total acreage in the subbasin needs to be precisely measured.
2. An adequate 100 year floodplain map needs to be developed. Also, the extent of floodplains for smaller frequency storms needs to be delineated.
3. Land use within the floodplain needs to be precisely identified.
4. The people of the subbasin need to be included in further water resource planning efforts. A public involvement program would provide a better fix on water resource problems and opportunities than is presently available.
5. Primary water and sediment quality data are needed, particularly for the areas in which flood control measures have been proposed. These data would be used to characterize the baseline condition so that specific environmental impacts can be formulated.
6. A literature search is needed to obtain all available biological information, much of which is located in libraries and agency depositories. In addition, fieldwork should be planned to fill data gaps, such as the baseline conditions with respect to fish and benthic populations. This baseline is needed to adequately assess environmental impacts.
7. Areas of high environmental quality should be identified and inventoried.
8. Studies are needed to determine additional demand for recreational facilities, usage of existing facilities, and potential sites.
9. More study is needed to determine the precise nature of the water supply problem and potential solutions.

10. A review of secondary sources and systematic field reconnaissance is needed to identify archeological and historical sites.

11. Crop distribution in the floodplain needs to be precisely identified through contact with county agents, and average annual rural damages need to be updated.

12. Urban damages need to be recomputed in a systematic fashion.

13. Gauging stations need to be developed on the Ottertail River to provide hydrologic data for establishing flood frequencies and rating curves.

14. Channel cross sections of the Ottertail River need to be prepared for flood control planning purposes.

15. The effect of drainage works on flood discharges and stages is unknown at present. It would take additional, more detailed studies to determine the extent and effect of reduced natural storage.

16. Potentialities for natural storage need to be thoroughly investigated.

17. Potentialities for floodwater storage in present drainage ditches needs to be investigated.

18. A detailed social profile of the subbasin is needed.

19. Knowledge of the location, areal extent, and types of wetlands in the subbasin would be useful in determining whether wetland restoration would assist in alleviating flooding problems.

20. The potentiality for land treatment measures needs to be thoroughly investigated.

21. Potential hydropower sites need to be identified.

22. The use for flood control of present water level control structures on the lakes needs to be investigated.

23. The irrigation potentials of the subbasin soils needs to be investigated.

24. Information on wastewater management needs to be updated.

25. The plan of operation for Orwell Reservoir should be reevaluated.

26. The nature and extent of flooding in the upland areas needs to be precisely determined.

27. The formation of a watershed district needs to be considered.

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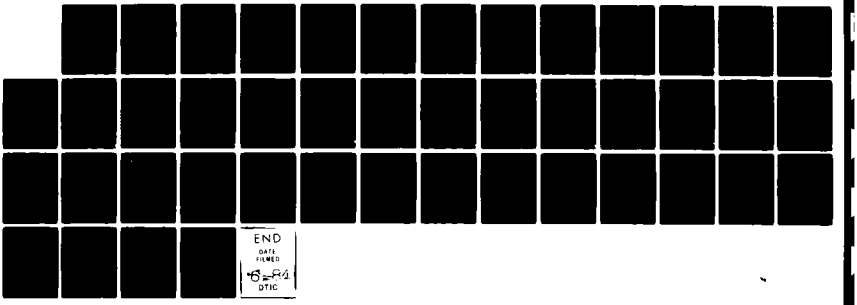

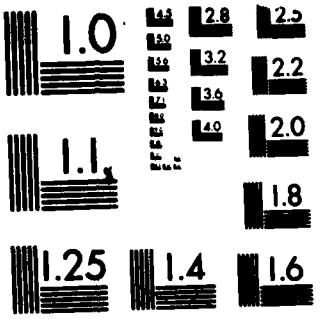

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Appendix A
FLOODPLAIN DELINEATION

Appendix A
FLOODPLAIN DELINEATION

Prior to this study, no attempt was made to publish even a generalized delineation of the entire Ottertail River Subbasin floodplain. In undertaking this task, the present study utilized all known sources to provide the best available data for generalized delineation at a scale of 1:250,000. Principal sources were: USGS Flood Prone Area Maps (scale 1:24,000), Federal Insurance Administration flood maps (various scales), published secondary sources, U.S. Geological Survey (USGS) 7 1/2 minute topographic maps, and other sources, including derived data where necessary.

The Flood Prone Area Maps published by the USGS provided detailed and accurate information for the area mapped. Unfortunately, only one sheet covering a small portion of the subbasin contigious to the main stem Red River was available.

Federal Insurance Administration Flood Hazard Boundary Maps and Flood Insurance Rate Maps provide important coverage of the Minnesota portion of the Red River Basin. The former are designed only to delineate the 100-year floodplain. The latter are much more detailed and therefore usually more accurate. The subbasin is comprised principally of parts of five counties. A Rate Map provided coverage in the unincorporated area of Wilkin County adjoining the Red River. Boundary Maps provided coverage for the most of the subbasin (Ottertail, Becker, and Clearwater counties). A flood study has not been made for Mahnomen County, which comprises a small part of the northern tip of the subbasin.

Other published secondary sources were also utilized. Floodplain descriptions and acreages in the Cormorant Lakes Watershed Overall Plan were consulted. As was explained in Section III of this report, descriptive accounts of the Ottertail floodplain from the Souris-Red-Rainy River Basins Comprehensive Study formed the basis for the crosshatch pattern in Figure II. U. S. Geological Survey 7 1/2 minute topographic maps of relevant areas were not available for consideration at the time the floodplain delineation was being made.

Data from the above sources (both delineated and descriptive) were compiled and delineated on USGS 250,000 scale maps. The indicated floodplain was then planimetered in whole and by segment with figures converted to land measure and rounded to the nearest 2,000 acres. The less definitive crosshatched areas were rounded to the nearest 5,000 acres.

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL
FACILITIES OTTERTAIL SUBBASIN

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INVENTORY OF OUTDOOR R
OTTERTAIL

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground: Primitive	Campground: Modern	Campground: Group	Wildlife Management Acres
1	Clearwater 23-WMA	State	DNR[6]	Clearwater Co. 14338W20 Angus Lake	36.2					36.0
2	Clearwater 25-WMA	State	DNR	Clearwater Co. 14338W29 Evey Lake	24.5					24.5
3	Clearwater 24-WMA	State	DNR	Clearwater Co. 14338W23 Little Rock Lake	40.0					40.0
4	Clearwater 26-WMA	State	DNR	Clearwater Co. 14338W35 Pickerel Lake	34.9					34.9
5	Tamarac National Wildlife Refuge	Federal	USFWS[7]	Sugar Bush Township 14139W00	42,382.0					41,000
6	Bubbel Pond WMA	State	DNR[6]	Becker Co. 13940W01 Cotton Lake	3,382.2					
7	Silverleaf Township Game Refuge	Township		Becker Co. 13939W13 Silverleaf Township	N/A					
8	Frank WMA	State	DNR	Becker Co. 13941W14 Floyd Lake	1,021.0					299
9	Pickerel WMA	State	DNR	Becker Co. I3940W15 Pickerel Lake	960.0					320
10	Scrambler WMA	State	DNR	Otter Tail Co. 13743W22 Tamarac Lake	25.0					
11	Dead Lake WMA	State	DNR	Otter Tail Co. 13540W21 Dead Lake	762.8					602.0
12	Homestead WMA	State	DNR	Otter Tail Co. 13637W31 New York Mills	45.0					

Appendix B

OUTDOOR RECREATIONAL FACILITIES[1]
OTTERTAIL SUBBASIN

Ground				Marina									Trails (Miles)									
Group	Wildlife Management Area	Athletic Field Area	Golf	Canoe	Rental[2]	Storage[3]	Playground	Park[4] Ramp	Picnic Table	Beach	Pool	Nature	Horse	Snow	Hike	Bike	Ski	Trout	Shooting Range	Rest Area	Fairground	Date[5]
	36.0																					71
	24.5																					71
	40.0																					71
	34.9																					71
	41,000								33			X		16	16							72
																						76
	299																					71
	320																					71
																						76
	602.0																					71
																						76

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Number	Name	Owner	Public Recreation Use	Location	Boundary Acres	Campground: Tent Sites	Campground: Trailer Sites	Picnic Tables	Fireplaces	Toilets	Drinking Water
(24)	[illegible]	State	yes	[illegible]	854.0						854.0
(25)	[illegible]	State	yes	[illegible]	298.0						
(26)	[illegible]	State	yes	[illegible]	145.0						
(28)	[illegible]	State	yes	[illegible]	670.0						
(27)	[illegible]	State	yes	[illegible]	60.0						60.0
(28)	Bergen Butte WMA	State	yes	Heber Toll Rd. [illegible] Bergen Butte	250.0						250.0
(29)	Hewett WMA	State	yes	Heber Toll Rd. [illegible] Hewett	1,957.0						1,957
(30)	Watkins WMA	State	yes	Heber Toll Rd. [illegible] Lake Isabella	278.0						278.0
(31)	Mt View WMA	State	yes	Heber Toll Rd. [illegible] Lake Isabella	110.0						110.0
(32)	Gibson WMA	State	yes	Heber Toll Rd. [illegible] Gibson	120.0						120.0
(33)	Independence WMA	State	yes	Heber Toll Rd. [illegible] Two's Lake	60.0						60.0
⚠	Rock Hut Resort	Private		Pleasanton Rd. [illegible] Gibson Lake	60.0	8					1
⚠	Ye Dew Resort	Private		Barker Rd. [illegible] Pikes Lake	80.0	9					

Appendix B

OUTDOOR RECREATIONAL FACILITIES[1]
OTTERTAIL SUBBASIN

Campground					Marina									Trails (Miles)									
Modern	Group	Wildlife Management Acres	Athletic Field Acres	Golf	Canoe	Rental[2]	Storage[3]	Playground	Park	Ramp	Picnic Table	Beach	Pool	Nature	Horse	Snow	Hike	Bike	Ski	Trout	Shooting Range	Rest Area	Fairground	Data[3]
		606.0																						71
																								76
																								71
																								77
		40.0																						71
		250.0																						71
		1,957																						71
		128.0																						71
		110.0																						71
		120.0																						71
		60.0																						71
			1			X	X	X	2			X				2	2					X		71
								X				X				1	1	1						78

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Appendix

INVENTORY OF OUTDOOR RECR
OTTERTAIL SU

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground			Wildlife Management Acres	Athletic Field
							Primitive	Modern	Group		
3	Pike Lake Resort and Campground	Private		Becker Co. 14238W08 Pike Lake	38.8			16			
4	Jolly Fisherman Resort	Private		Becker Co. 14238W05 Elbow Lake	30.0	12					
5	R & R Resort	Private		Becker Co. 14239W12 Horseshoe Lake	28.9	3					
6	Rainbow Resort	Private		Becker Co. 14239W24 Little Bemidji Lake	360.0	5		4			
7	Tamarac Resort	Private		Becker Co. 14139W12 Round Lake	100.0	13		4			
8	White Earth State Forest	State	DNR[6]	Reservation	54,400.00						
9	Ice Cracking Lodge	Private		Becker Co. 14138W20 Ice Cracking Lake	87.4	6	6	6			4
10	Happy Hunting Campground	Private		Becker Co. 14138W20 Ice Cracking Lake	30.0			30			
11	Holm's Hide-A-Way Resort	Private		Becker Co. 14038W18 Island Lake	80.0	7		2			
12	Ray's Resort	Private		Becker Co. 14039W24 Island Lake	18.0	8					4
13	Valhalla Resort	Private		Becker Co. 14038W08 Island Lake	697.0	8		10			1
14	Camp Tamarac Group Camp	Federal	DNR[6]	Becker Co. 14039W22 Height of Land Lake	194.0				250		4
15	Bambi Resort	Private		Becker Co. 13938W09 Toad Lake	68.0	13					

Appendix B

OF OUTDOOR RECREATIONAL FACILITIES[1]
OTTERTAIL SUBBASIN

Campground					Marina								Trails (Miles)									
Modern	Group	Wildlife Management Acres	Athletic Field Acres	Golf	Canoe	Rental[2]	Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Nature	Horse	Snow	Hike	Bike	Ski	Trout	Shooting Range	Rest Area	Fairground	Date[5]
16						X		X			3	X			1		3							76
						X	X	X	6		6	X					4							76
						X																		76
4						X	X		8	X		X				1								78
4						X		X	10			X					4	4						71
6			4		X	X		X	5	X	6				3	3	3	1						76
30								X	30			X												71
2					X	X	X	X	10		12	X					8	5						71
			4			X		X			8	X												76
10			1		X	X	X	X			12					8	4	1						76
	250		4						8	X		X												77
						X		X				X												76

-continued-

Appendi

INVENTORY OF OUTDOOR RECR
OTTERTAIL S

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground			
							Primitive	Modern	Group	Wildlife Management Area
16	Little Toad Lake Campground	Private		Becker Co. 13939W24 Little Toad Lake	48.0			71		
17	Birchmere Resort	Private		Becker Co. 13939W24 Little Toad Lake	126.0	8		5		
18	Pine Cone Resort Camp	Private		Becker Co. 13940W12 Cotton Lake	1,649.0	10				
19	Snyder's Resort	Private		Becker Co. 13940W15 Pickerel Lake	37.0	6	1	1		
20	Detroit Minnesota Ski Area	Private		Becker Co. 13940W31 McHugh	260.0					
21	Lakecrest Resort	Private		Becker Co. 13941W29 Long Lake	20.0	15				
22	Long Lake Camp-site and Trailer	Private		Becker Co. 13941W30 Long Lake	50.0			82		
23	Meadow Lake Campsite, Inc. Campground	Private		Becker Co. 13841W21 Meadow Lake	68.0			84		
24	Riverside Place Resort	Private		Becker Co. 13841W32 Lake Melissa	100.0	6				
25	Camp Tee Pee	Private		Becker Co. 13843W01 Big Cormorant Lake	220.0			57		
26	Viking Bay Resort	Private		Becker Co. 13843W01 Big Cormorant Lake	22.0	10		50		
27	Cormorant Inn Resort	Private		Becker Co. 13842W18 Big Cormorant Lake	22.0	18	4			

Appendix B

OOR RECREATIONAL FACILITIES[1]
RTAIL SUBBASIN

Group	Wildlife Management Acres	Athletic Field Acres	Golf	Marina: Canoe	Marina: Rental[2]	Marina: Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Trails (Miles): Nature	Trails (Miles): Horse	Trails (Miles): Snow	Trails (Miles): Bike	Trails (Miles): Bike	Trails (Miles): Ski	Trout	Shooting Range	Boat Area	Fairground	Date[5]
		1			X	X	X	40	X	50		X	X				3						76
		1			X		X	25	X		X												71
					X						X												71
					X																		76
															1								77
		2			X		X	5		14	X				1								76
		2		X	X	X	X	6	X	8	X					1	1						76
					X		X	5			X												78
					X		X			8	X												76
				X	X	X	X	30		4	X		X										71
		2		X	X	X	X	6	X		X					5							76
		2			X		X	20	X		X	X											77

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Appendix B

INVENTORY OF OUTDOOR RECREATIONAL
OTTERTAIL SUBBASIN

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground			Wildlife Management Acres	Athletic Field Acres
							Primitive	Modern	Group		
28	Fair Hills Resort	Private		Otter Tail Co. 13742W04 Pelican Lake	34.0	72					4
29	Strom's Resort	Private		Otter Tail Co. 13742W02 Pelican Lake	150.0	6	4				
30	Camper's Point Campground	Private		Otter Tail Co. 13742W08 Fish Lake	265.0		125	10			2
31	Dunn's Lodge	Private		Otter Tail Co. 13742W20 Lake Lizzie	250.0	27					
32	Bo's Resort	Private		Otter Tail Co. 13742W30 Lake Lizzie	170.0	1					
33	Stender's Rose Lake Resort	Private		Otter Tail Co. 13740W17 Rose Lake	52.5	5		1			
34	Sunset Bay Resort	Private		Otter Tail Co. 13740W27 Long Lake	72.0	8					
35	Houdeck's Resort	Private		Otter Tail Co. 13639W02 Little Pine Lake	32.0	9		2			
36	Lakeside Municipal Park	Municipal		Otter Tail Co. 13639W02 Little Pine Lake	38.0						
37	Perham Municipal Park & Recreation Area	Municipal		Otter Tail Co. 13639W11 Perham	310.0						
38	Jungle Shores Resort	Private		Otter Tail Co. 13738W31 Big Pine Lake	16.0	10	12	12			
39	Koehler's Resort	Private		Otter Tail Co. 13638W23 Big Pine Lake	33.0	7		15			

Appendix B

TDOOR RECREATIONAL FACILITIES[1]
TTERTAIL SUBBASIN

ground			Marina							Trails (Miles)											
Cabins	Group	Wildlife Management Acres	Athletic Field Acres	Golf	Canoe	Rental[2]	Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Nature	Horse	Snow	Hike	Bike	Ski	Trout	Shooting Range	Boat Area	Fairground	Date[5]
			4	9	X	X						X	X											76
						X			1		5	X												76
30			2			X	X	X	118		125	X						33						76
				9	X	X	X	X	50	X		X												76
						X																		71
1						X		X			5													71
								X			2	X												76
2						X						X												71
								X	25			X												76
																								76
12								X	10			X												76
9																								76

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Appendix B

INVENTORY OF OUTDOOR RECREATION
OTTERTAIL SUBBASIN

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground			Wildlife Management Area	Athletic Field Acres
							Primitive	Modern	Group		
40	Cal's Rainbow Point Resort	Private		Otter Tail Co. 13539W07 Marion Lake	20.0	10					
41	Rush Lake Tent-Trailer Park	Private		Otter Tail Co. 13538W29 Rush Lake	55.0			60			3
42	Simmons Resort	Private		Otter Tail Co. 13439W15 Pelican Bay	50.0	5					
43	East Silent Lake Cottages	Private		Otter Tail Co. 13641W33 East Silent Lake	50.0	9					1
44	Wildwood Resort	Private		Otter Tail Co. 13641W36 Round Lake	19.0	5					
45	North Star Resort	Private		Otter Tail Co. 13641W36 Pine Lake	40.0	9	6	28			1
46	Whitehaven Resort	Private		Otter Tail Co. 13540W16 Dead Lake	38.0	7					
47	Sunrise Resort	Private		Otter Tail Co. 13540W25 Dead Lake	50.0	5					
48	Spruce Lodge Resort	Private		Otter Tail Co. 13541W14 Star Lake	40.0	8					
49	Deer Trail Lodge	Private		Otter Tail Co. 13541W09 Star Lake	54.3	6	8	7			1
50	Ringswood Resort	Private		Otter Tail Co. 13541W09 Star Lake	66.0	8		8			
51	Maple Beach Resort	Private		Otter Tail Co. 13642W32 Lake Lida	15.0	12					
52	Grove Point Resort	Private		Otter Tail Co. 13542W05 South Arm Lida Lake	58.0	12					

Appendix B

OOR RECREATIONAL FACILITIES[1]
RTAIL SUBBASIN

Group	Wildlife Management Area	Athletic Field Acres	Golf	Marina: Canoe	Marina: Rental[2]	Marina: Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Trails (Miles): Nature	Horse	Snow	Hike	Bike	Ski	Trail	Shooting Range	Rest Area	Fairground	Date[5]
					X		X	125		7	X												77
		3			X			30			X												77
																							71
		1			X		X	4			X					1							76
																							71
		1		X	X		X	20		15	X					2							76
																							71
					X				X	2													77
				X	X	X	X	50			X												76
		1			X		X	50	X	5	X												76
					X	X	X	10	X	5	X				3					X			76
					X	X	X				X												78
					X		X	20	X	4	X												76

-continued-

Appendix

INVENTORY OF OUTDOOR RECRE
OTTERTAIL SU

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground: Primitive	Campground: Modern	Campground: Group	Wildlife Management Area
53	Maplewood State Park	State	DNR[6]	Otter Tail Co. 13642W25 Pelican Rapids	92,330.0			51	X	
54	Woo Villa Resort	Private		Otter Tail Co. 13443W12 Long Lake	37.9	8		89		
55	Jewett Lake Resort	Private		Otter Tail Co. 13443W24 Jewett Lake	20.0	10	3	6		
56	Twin Lake Landing	Private		Otter Tail Co. 13440W18 Twin Lakes	23.0	4		15		
57	Maple Leaf Resort	Private		Otter Tail Co. 13441W29 West Lost Lake	30.0	6				
58	Westlake Resort	Private		Otter Tail Co. 13441W32 West Lost Lake	32.7	8				
59	Twin Pine Resort	Private		Otter Tail Co. 13441W32 West Lost Lake	20.0	10		8		
60	Shady Ray Resort	Private		Otter Tail Co. 13341W02 East Lost Lake	30.0	5		4		
61	Whispering Waters Resort	Private		Otter Tail Co. 13341W01 East Lost Lake	28.0	5		1		
62	Otter Tail Lake Campground	Private		Otter Tail Co. 13340W03 Otter Tail Lake	35.0			49		
63	Lake Alice Municipal Park	Municipal		Otter Tail Co. 13343W34 Fergus Falls	45.0					
64	Roosevelt Municipal Park	Municipal		Otter Tail Co. 13343W35 Fergus Falls	17.0					

Appendix B

OR RECREATIONAL FACILITIES[1]
TAIL SUBBASIN

Group	Wildlife Management Acres	Athletic Field Acres	Golf	Marina: Canoe	Marina: Rental[2]	Marina: Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Trails (Miles): Nature	Horse	Snow	Hike	Bike	Ski	Trail	Shooting Range	Boat Area	Fairground	Code[5]
X										18	X			19	25	20		7					76
		3		X	X	X	X	50		90	X												77
					X	X	X	6		2	X												77
				X	X			10			X												76
										3													76
											X												76
		1			X		X				X												76
							X				X												76
		2		X	X		X				X												76
				X	X		X	100		65	X		X	1									76
										10													76
							X			40													76

-continued-

App

INVENTORY OF OUTDOOR
OTTERTA

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground: Primitive	Campground: Modern	Campground: Group
65	De Lagoon Municipal Park	Municipal		Otter Tail Co. 13243W11 Fergus Falls	192.2			24	
66	Lake Iverson Rest Area	State	MHD[8]	Otter Tail Co. 13243W23 Lake Iverson	50.0				
67	West Side Municipal Park	Municipal		Otter Tail Co. 13243W05 Fergus Falls	52.0				
68	Bonnie Beach Resort	Private		Otter Tail Co. 13240W11 Clitherall Lake	15.0			3	
69	Old Town Camp and Trailer Park	Private		Otter Tail Co. 13240W12 Clitherall Lake	21.0	11		7	
70	Sunset Beach Resort	Private		Otter Tail Co. 13339W28 West Battle Lake	18.0	6		10	
71	Linden Park Resort	Private		Otter Tail Co. 13339W26 East Battle Lake	29.0	4		20	
72	Maple Lane Resort	Private		Otter Tail Co. 13339W35 Stuart Lake	32.5	7		4	
73	White Oaks Resort	Private		Otter Tail Co. 13239W02 East Battle Lake	120.0	3			
74	Oak Park Resort	Private		Otter Tail Co. 13239W06 Clitherall Lake	20.0	8			
75	Lakeview Resort	Private		Otter Tail Co. 13239W03 Stuart Lake	49.0	4		4	

Appendix B

OUTDOOR RECREATIONAL FACILITIES[1]
OTTERTAIL SUBBASIN

Campground					Marina									Trails (Miles)									
Modern	Group	Wildlife Management Acres	Athletic Field Acres	Golf	Canoe	Rental[2]	Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Nature	Horse	Snow	Bike	Bike	Ski	Trout	Shooting Range	Boat Area	Fairground	Date[5]
24								X	10	X	80	X												76
											5											X		75
																	1							76
3					X	X				X		X												76
7			1			X	X	X	5	X	7	X												71
10						X	X						X											71
20						X						X												71
4						X						X												76
						X	X			X		X												76
			2			X		X	2			X												72
4			3		X	X		X	4		7	X												76

-continued-

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App

INVENTORY OF OUTDOO
OTTER

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground		
							Primitive	Modern	Group
(1)	Height of Land Trail	N/A		Becker Co. 14238W01 Pine Island Lake					
(2)	Old Indian Hiking Trail	N/A		Becker Co. 14039W17 Tamarac Lake					
(3)	Pine Lake XC . Ski Trail	N/A		Becker Co. 14039W19 Tamarac Lake					
(4)	Winter Wonderland Snow Trail	N/A		Becker Co. 13939W01 Height of Land Township					
(5)	Ironman Golf Course	Private		Becker Co. 13941W10 Floyd Lake	45.0				
(6)	Detroit Lakes High School Athletic Field	School		Becker Co. 13941W27 Detroit Lakes	36.0				
(7)	Detroit Lakes Vo-Tech Athletic Field	School		Becker Co. 13941W26 Detroit Lakes	28.0				
(8)	Frazee High School Forest	School		Becker Co. 13840W12 Frazee	240.0				
(9)	Perham Municipal Golf Course	Municipal		Otter Tail Co. 13639W02 Little Pine Lake	93.0				
(10)	Perham School Athletic Field	School		Otter Tail Co. 13639W15 Perham	20.00				
(11)	Balmoral Golf Course	Private		Otter Tail Co. 13439W31 Balmoral	113.0				

Appendix B

OF OUTDOOR RECREATIONAL FACILITIES[1]
OTTERTAIL SUBBASIN

Campground					Marina									Trails (Miles)									
Modern	Group	Wildlife Management Area	Athletic Field Acres	Golf	Canoe	Rental[2]	Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Nature	Horse	Snow	Hike	Bike	Ski	Trout	Shooting Range	Rest Area	Fairground	Date[5]
															N/A									79
															N/A									79
															N/A									79
															N/A									79
				18																				76
			36					X																76
			28																					76
														X										76
				9																				76
			20					X																75
				18																				77

-continued-

Number	Name	Own	Administration	Location	Boundary Acres	Number of Resort Units	Campground: Primitive	Campground: Modern	Campground: Group
(12)	Battle Lake School Athletic Field	Public School		Otter Tail Co. 13340W33 Battle Lake	20.0				
(13)	Fergus Falls Senior High Athletic Field	Public School		Otter Tail Co. 13343W35 Fergus Falls	16.5				
(14)	Pebble Lake Municipal Golf Course	Municipal		Otter Tail Co. 13243W14 Pebble Lake	140.0				
(15)	Fergus Falls Jr. High School Athletic Field	Public School		Otter Tail Co. 13243W10 Fergus Falls	41.2				

[1]Facilities included are limited to those with 15 or more acres.

[2]Boat rental.

[3]Boat storage.

[4]Parking spaces.

[5]Date of latest facility information.

[6]Department of Natural Resources.

[7]United States Fish and Wildlife Service.

[8]Minnesota Highway Department.

Source: Department of Natural Resources, Division of Parks and Recreation, State of Minnesota.

Appendix B

OUTDOOR RECREATIONAL FACILITIES[1]
OTTERTAIL SUBBASIN

ground			Marina								Trails (Miles)									
Modern	Group	Wildlife Management Acres	Athletic Field Acres	Golf	Canoe	Rental[2]	Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Nature	Horse	Snow	Hike	Bike	Ski	Trout	Shooting Range	Rest Area	Fairground	Date[5]
			20					X				X												76
			10																					76
				18																				76
			15																					76

ota.

Appendix C

COMMENTS

Appendix C
COMMENTS

The purpose of this subbasin report was to provide an overview of the water and related resource problems and needs and to assess potential solutions. Toward this end, draft copies of this report were circulated to Federal, State, and local agencies and comments were sought.

This review resulted in complete and factual documentation. Thus, the study should serve as a building block for the timely completion of future water resource efforts within the subbasin. Further cooperative efforts are, however, needed to evaluate these tentative results and to develop potential solutions.

A distribution list and copies of the comments made with respect to the draft report are included as part of this appendix. Comments that resulted in specific modifications to the draft text are marked by an asterisk.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

8 July 1980

Mr. Mike Liffmann
Project Manager
Gulf South Research Institute
8000 GSRI Avenue
Baton Rouge, Louisiana 70808

Dear Mr. Liffmann:

The draft Ottertail River subbasin report was distributed for review and comment. Most of the reviewers have sent their comments to us.

a. Inclosure 1 includes letters from various Federal and State agencies.

b. Inclosure 2 is the general office comments that need to be considered when preparing the final Ottertail River subbasin report and the remaining subbasin reports.

c. Inclosure 3 identifies specific office concerns that are applicable to the final Ottertail River subbasin report.

If you have any questions on our comments or proposed modifications, please contact us.

Sincerely,

Louis E Kowalski

LOUIS E. KOWALSKI
Chief, Planning Branch
Engineering Division

3 Incl
As stated

United States Department of the Interior
FISH AND WILDLIFE SERVICE
IN REPLY REFER TO:
St. Paul Field Office Ecological Services
538 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

23 MAY 1980

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

This provides U.S. Fish and Wildlife Service comments on the Draft Reconnaissance Report recently compiled by Gulf South Research Institute for the Ottertail River Subbasin in Wilkin, Ottertail, Becker, Clay, Mahnomen, and Clearwater Counties, Minnesota.

As expressed in our comments on previous Subbasin Reports, our major concerns are associated with the woodland, grassland, wetland, riverine, and riparian floodplain habitats that continue to exist within this Subbasin. The Ottertail River Subbasin is one of the richest Subbasins in the Red River Basin with respect to natural resources. This is particularly true in the upper two-thirds of the Subbasin where the Ottertail River flows through an extensive network of lakes, wild rice marshes, and some of the finest recreational resources of the region. However, in the southern one-third of the Subbasin (particularly Wilkin County and southwestern Ottertail County) much of the grassland, woodland, and wetland habitat has been converted to agricultural uses. Table 13 on page 45 of the Report shows that approximately 9,400 acres of Type 3, 4, and 5 wetland habitat were lost in Mahnomen, Clay, Becker, Wilkin, and Ottertail Counties during the 10 year period from 1964 to 1974. We agree with the statements on page 12 and 27 of the Report that the drainage of wetlands is a particular area of concern and that there is a need to preserve, and where possible, enhance the remaining wetlands, woodlands, and grasslands within Subbasin.

Another area of concern with respect to this Subbasin is the Ottertail River itself which is one of Minnesota's most beautiful streams. The River is rich in aquatic invertebrates and fish (42 species identified to date by the Minnesota Department of Natural Resources), is famous for its clean water and variety of habitat, is an outstanding canoeing and boating stream, and is an extremely important recreational, water power, and scenic resource. As such, no actions and/or measures should be undertaken within the Subbasin that would inappropriately degrade this important riverine resource.

Incl 1

The report indicated that overbank flooding problems in the lower part of the Subbasin have essentially been taken care of by existing measures (Orwell Dam, etc.). The only structural flood reduction measure recommended in the Report for the Ottertail River Subbasin was for control structures and channel improvements in the area of Big Cormorant Lake to stabilize water levels and eliminate flooding on approximately 380 acres of lakefront property. The Report indicates that construction of the control structures at the lower end of Big Cormorant Lake and other smaller tributary lakes (such as Bejou and Leif Lakes) would likely induce increased residential lakeshore development around these lakes which will degrade the shoreline habitats for both wildlife and aquatic biota. The recommended channel improvements would remove wetland and riparian habitat in the natural drainages between Big Cormorant Lake and Pelican Lake and between Pelican Lake and Lake Lizzie. We have substantial problems with channelization proposals, as previously stated in our comment letter relative to Alternative A in the Draft Reconnaissance Report on the Tamarac River Subbasin. We agree with the statement on page 56 of the Report that in order to devise an effective flood damage reduction program, the extent to which upland drainage patterns contribute to flooding in the Subbasin needs to be determined. We also believe that strong consideration should be given to the possibility or restoring wetlands within the Subbasin and, particularly, in the Cormorant chain of lakes area as addressed on page 69 of the Report.

We fully agree that additional studies (particularly numbers 3, 15, 16, 17, 19, and 20 addressed on pages 71 and 72 of the Report) need to be undertaken in order to provide a more detailed and in-depth analysis of existing Subbasin problems and the potential solutions to many of these problems.

Generally, we believe the Draft Report was well written and sets forth a good overview of the water and related land resources, problems, and possible solutions to some of these problems within this Subbasin of the the Red River of the North. We suggest, however, that the following seven changes be made in the Final Report:

* 1. Page 42, last paragraph under the heading Waterfowl Production Areas - change this paragraph to read as follows:

> Numerous Federal Waterfowl Production Areas (WPA's) are located within the Ottertail River Subbasin. These are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of Migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These WPA's are significant

because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as provide valuable habitat for migratory waterfowl and many other forms of wildlife. The USFWS is responsible for the compatibility determinations (uses) and the issuance or denial of permits involving these lands. The approximate locations of these WPA's (fee tracts) within the Subbasin are shown in Figure IV. Total acreage of these WPA's (fee and easement) within Mahnomen, Clay, Becker, Wilkin, and Ottertail Counties are given in Table 14.

* 2. Page 46, Figure IV - put a dot before Waterfowl Production Areas and fee tracts in parenthesis after it in the legend.

* 3. Page 47, Table 14 - remove the cost column which is not necessary in this Report and simply put Fee (Acres) and Easement (Acres) above the appropriate acreage columns. In addition, change the title to read ACRES OF FEDERAL WATERFOWL PRODUCTION AREAS (FEE AND EASEMENT) IN FIVE OF THE SIX COUNTIES OF THE OTTERTAIL RIVER SUBBASIN.

* 4. Page 48, 2nd paragraph, last sentence - put Figure IV in parenthesis after the word prairies. These prairies are not identified until you get to the next page under the heading Natural Areas.

5. Page 49, 2nd paragraph, 1st sentence - we suggest this sentence begin with Reptile and amphibian species of special interest.

6. Page 59, 2nd paragraph, 5th sentence - we recommend the sentence, "Information on natural storage areas and potentialities for increased storage is not available" be deleted and instead include similar comments as addressed in the last paragraph on page 69.

* 7. Page 69, last sentence - we suggest this sentence be changed to read as follows:

Correlated with this consideration is the protection of existing wetlands, which were reduced by more than 9,000 acres in the counties included by the Subbasin during the 10 year period from 1964 to 1974.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.) and are consistent with the intent of the National Environmental Policy Act of 1969.

Sincerely,

Richard F. Berry

Richard F. Berry
Field Office Supervisor

cc: Minn DNR, St. Paul
S. Bittner, Gulf South Res. Inst., New Iberia

Corps of Engineers
North Central Division
Comments on the Ottertail River Subbasin
30 May 1980

1. Page 8 - "100-year floodplain." As presented, the map is of poor quality. Is the southwest portion of the basin the only area where there is floodplain? Where is the legend?

2. Pages 7 and 9 - The discussion on the location and extent of the 100-year floodplain needs to be clarified. Suggest inclusion of a table for comparison, contrast, or just listing of acreages.

3. Page 15 - Discussion of irrigation implies an almost inexhaustible supply of groundwater. Surely this is not so. Have there been any studies which discuss groundwater depletion in relation to withdrawals for irrigation? Suggest contacting the U.S. Geological Survey.

4. Page 17 - Hydropower -- Who would market the power from Orwell Dam or another similar public facility?

5. Public perception - Why hasn't the Corps held any workshops or meetings in this subbasin? How can there be an intelligent discussion of needs without this type of input?

*6. Page 19 - Social characteristics - second paragraph -- Were the views of local officials gathered by a sample survey or a survey of all officials in all communities?

*7. Page 20 - Discussion of Amerind groups in the area should address these people as either American Indians or native Americans.

*8. Page 21 - The discussions concerning economic activities and sources of income appear to be contradictory. The first paragraph implies that, although this area is agriculturally oriented, the major portion of the income is from non-agribusiness. How can the total personal and per capita incomes fluctuate significantly from fluctuating farm prices?

9. Pages 24 and 25 - Discussion of trends in agriculture should be rectified with those on page 19 - Social characteristics, first paragraph. The views of locals appear to be contradictory to those stated in the trends discussion.

*10. Page 36 - Delete parenthetical phrase "(or Woman)". This is an unintelligent and tactless piece of rhetoric.

11. Architectural history should also be discussed. The numerous artisan styles should help to show the evolution of man's (Euro-American) adaptation to this area. If no work has been done, state so and include in additional study needs.

12. Discussion and/or research needs to be done on Paleo-man/Pleistocene megafaunal relationships. With the lakes formed from glacial recession there could have been some interaction here between man and the mastodon. Evidence of this is rare. However, evidence has been found in artesian wells and old boggy/marshy areas surrounding glacially formed lakes.

13. Page 62 - The list of objectives is basically good. However, include phrases in each objective that would indicate the purpose for the objective (for example, objective 2 should include a phrase about enhancing the environment for the preservation of a wildlife species or improving the quality of life or scenic diversity). All of the objectives are awkwardly phrased. Rearrange words to increase readability. Include a brief discussion of the national objectives (NED-EQ).

14. Pages 63-65 - Discussion of alternative formulation needs to be expanded. A series of alternatives is not presented, just one each - structural and non-structural. What about a combination? The figure also does not show the location of alternatives clearly.

15. Pages 66-69 - The assessment of alternatives does not tell how each alternative meets or does not meet each objective. There is no discussion of trade-offs. No comparisons are given. A table with the system of accounts should be presented. Conclusions about relative merits of each alternative cannot be made. In addition, there is no discussion which would satisfy the requirements of Executive Order 11988. Such discussion concerning floodplain development and management is necessary.

15. Page 10 - The last paragraph on page 10 states there were no rural flood damages during the 1975 and 1979 floods; however, average annual rural damages are substantial. Include a discussion of why there were no rural damages during the 1975 and 1979 floods and explain why rural damages are so great.

17. Page 66 - Include a precise discussion of the method used to calculate the damages and benefits.

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
444 Lafayette Road, Space Center Bldg., St. Paul, MN 55101
PHONE 612/296-4800

File No. _____

May 29, 1980

Colonel William W. Badger
St. Paul District
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

COMMENTS ON BOIS DE SIOUX - MUSTINKA AND OTTERTAIL RIVER SUBBASIN REPORTS

Thank you for the opportunity to review the above referenced documents.

The documents do a good job of presenting the existing information on each subbasin. There is still however, not enough detailed information provided on non-structural alternatives. The only feasible alternative identified in either of these reports is farmstead ring-dikes. Since most structural alternatives do not appear to be feasible it is necessary to provide much more information on the costs and benifits of non-structural alternatives including relocation, flood proofing, flood insurance, flood plain zoning and land treatment. It may not be possible for the Corps of Engineers to participate in some of these programs, but it is critical that all potentially feasible alternatives be investigated.

Attached are specific comments on the two subbasin reports. If you have any questions, please contact Joe Gibson at 612/296-0438 or Ron Harnack at 612/296-0440.

Sincerely,

DIVISION OF WATERS

Larry Seymour
Director

LS/JG:ph

cc: Joe Gibson
Ron Harnack

BOIS DE SIOUX - MUSTINKA RIVERS SUBBASIN

PAGE 54 - 1st PARAGRAPH -

It is unclear, draw riparian doctrine vs. appropriation doctrine affects comprehensive flood plain management in the subbasin.

PAGE 63 -

The adoption of flood plain zoning ordinances, relocation and flood-proofing should be examined in detail as an alternative.

Comprehensive land treatment at various levels (30% 50% 70% & 90%) of lands adequately protected is another alternative that should be examined in great detail in terms of both flood damage reduction and water quality improvements.

PAGE 64 -

The costs, benefits and effects of the two above mentioned non-structural alternatives should be displayed also.

OTTERTAIL RIVER SUBBASIN

* PAGE 10 -

How are average annual damages being determined for this subbasin and all other subbasins.

PAGE 63 -

The lakes in this part of the state have a wide range of level fluctuation. It is highly unlikely that water levels will continue to rise unchecked. This is currently a period of generally higher than normal precipitation and water levels will fall during years of less than normal precipitation. An alternative that should be examined is moving back homes that were constructed in or near the lake bed during periods of low water.

PAGE 63 - LAST PARAGRAPH -

It is unlikely that conditions such as this are prevalent throughout the upland portions of the subbasin.

* PAGE 65 -

Communities and counties are required to adopt flood plain zoning ordinances once sufficient data are available. Other non-structional measures such as flood proofing relocation and insurance should be looked at as one or more non-structural alternatives.

* PAGE 65 -

Various levels of land treatment for flood damage reduction, erosion, control and water quality improvement purposes should be evaluated as alternatives.

(continued)

PAGE 66 -

On page 11 it only shows $1300 of total residential damages. Not all of this occurs in the Cormorant Lake area.

PAGE 66 -

Other proposed non-structural alternatives should be examined in detail.

General Comments
Ottertail River Subbasin Draft Report
(April 1980)

(These comments apply to the entire report and all subsequent subbasin documents)

1. As indicated in the specific comments, this document needs additional detailed information concerning nonstructural alternatives. The overall report should address and clarify this aspect of flood damage reduction planning.

2. Comments from Federal, State, and local agencies and a letter from the St. Paul District will be included in an appendix in each final subbasin and in the overall report. The format for the appendix will be:

a. Introduction - This section should stress:

(1) The importance of completing the study on time.

(2) That the purpose of the study is to advise other agencies and interests.

(3) The need for a selected review by various interests to provide complete and factual documentation.

(4) The use of the study as a building block for future water resource efforts.

(5) That cooperative efforts to evaluate results and develop solutions to remaining problems will be incorporated.

(6) A complete public involvement program when the study is finished.

b. The distribution list.

c. Copies of letters of comment.

Only comments that identify significant errors or need specific attention will be addressed in the final subbasin report. However, all comments incorporated should be identified with a marking system. The distribution list for the Ottertail River Subbasin Report is given below:

Agencies receiving draft report	Date sent	Date comments received
Federal		
Soil Conservation Service	9 May 80	-
Fish and Wildlife Service	9 May 80	23 May 80
Corps of Engineers, North Central Div.	7 May 80	30 May 80
Corps of Engineers, St. Paul District	7 May 80	20 May 80

Water Planning Board	9 May 80	-
Department of Natural Resources	9 May 80	29 May 80
Planning Agency	9 May 80	-
Water Resources Board	9 May 80	-

Local

Civil Defense Director	9 May 80	-
City of Breckenridge	9 May 80	-

3. The source for most information identified in the majority of the tables is Gulf South Research Institute. If other sources were used, an appropriate reference should be made.

Specific Comments
Draft Ottertail River Subbasin Report
(April 1980)

*+1. Page 2 - After the last sentence, add: "The main report will consider the possibility of various water resource-oriented agencies serving as vehicles for implementing flood damage reduction actions and undertaking additional study needs."

* 2. Page 3, first line - The basin is not elliptical.

* 3. Page 3, 2nd line - This should read "in Minnesota in the southern portion of the Red River basin," instead of "southern Minnesota portion."

4. Page 4, Figure I - The Bois de Sioux River should be identified.

* 5. Page 7, 1st paragraph - The statements that the extent of flooding in this area cannot be determined and that problems have resulted from improper regulation of headwater lake levels are conflicting. The comment relating to problems associated with regulation of headwater lakes may be improper without substantial information to back it up.

* 6. Page 7, last paragraph - The 100-year floodplain has been delineated, otherwise there would not be flood-prone area maps, Federal insurance maps, etc. Although many of these may disagree because of the various criteria and regulations under which each one was developed, a general delineation can be accepted.

7. Page 8, Figure II - The 100-year floodplain outline is sufficient for report purposes; however, for identification of flood-prone acres and additional discussions, we assume that a more detailed map was used. We would like this (these) map(s) when the study is completed. A legend should be included on the map(s).

8. Page 9 - The discussion on the location and extent of the 100-year floodplain needs to be clarified. We suggest a table for comparison or contrast or for listing acreages. The Toad River is not located on the map; but it is listed as having a substantial floodplain compared with the entire subbasin. Discussions on the lower Ottertail River floodplain should be modified. The number of floodplain acres in paragraph 2 does not agree with that suggested in the latter half of paragraph 3.

10. Page 10, last paragraph - The average annual rural flood damages are substantial when compared to urban annual flood damages, not when compared to many of the other subbasins in the Red River basin.

11. Page 14, Erosion Problems Section - The Minnesota U.S. Geological Survey does not measure nutrients and suspended sediment loadings in the Ottertail River (according to the 1978 water supply papers). The source for the second and third from the last sentences should be stated. There could be adverse reactions to undocumented generalizations about land use practices. On page 15, the last sentence mentions a Minnesota Pollution Control Agency report on water quality. If this source was used, appropriate credit should be given.

Incl 3

12. Page 17, Hydropower Section - The Ottertail River could be an important part of future water resource development in the Ottertail River subbasin. Inadequate streamflows may be a problem as noted in the Water Quality Section on page 13. It might be necessary to refer to the National Hydropower Study and identify whether the facilities (existing and potential) are included in this study. This may clarify this aspect.

* 13. Page 17, Public Perception of Problems and Solutions Section - Although no official public meetings have been held for residents of the Ottertail River subbasin there have been informal meetings and discussions with local interests. Local interests have participated in meetings held throughout the basin to discuss flood control problems, needs, and solutions. They have requested Red River main stem interests to attend meetings in their areas to discuss the downstream problems and concerns. The Corps representative at the Orwell Dam and lake attends local meetings and helps provide good two-way communication between the Corps and the public concerning water resource problems.

14. Page 20, Income Section - The total personal income for the subbasin increased from $217 million to $302 million between 1969 and 1977. This is a 39-percent increase in 8 years. This agrees with the interim growth derived from curves drawn from OBERS Water Resource Subarea #902 and BEA Economic Area #97. What was the correction factor used, if the 1969 figure is expressed in 1979 dollars?

* 15. Page 22, Manufacturing Section - The statement "excellent water supply sources" should be explained in light of the statement on page 14 which says that "full development is limited by low flows, evaporation and seepage losses, and lack of suitable reservoir sites." If the manufacturers use groundwater as a source, the quality may cause problems. This statement should be qualified.

* 16. Page 24, 2nd paragraph - Pelican Rapids is misspelled.

17. Page 24, Land Use Section - The land use totals 96.8 percent. What makes up the remaining 3.2 percent?

* 18. Page 25, 2nd paragraph - Should the growing season be "127 days" instead of "27 days"?

* 19. Page 28, 1st paragraph - The last sentence indicates that the river otter reaches the southern limit of its range in Minnesota and in the upper reaches of the subbasin. While the otter may be more prevalent in the northern half of Minnesota, it can be found along the Mississippi River to Iowa. This should be clarified.

* 20. Page 28, 2nd paragraph - Reference is made to Region 15 without explaining what this refers to. It is assumed that this is the Department of Natural Resources Management Unit. If so this should be clarified.

21. Page 31 - This table is difficult to read.

22. Page 36, Cultural Elements Section - This section is much better than that presented in the draft Middle and Tamarac River subbasin reports. Further clarification is requested to provide conclusions about any viable alternatives.

* 23. Page 36, 1st paragraph - "Wedel" is cited but is not included in the bibliography.

24. Page 38, Figure III - This figure is difficult to read. A foldout may be more appropriate.

25. Page 39, 2nd paragraph - What is the Governor's program to build ring dikes? This should be clarified and additional information should be provided.

26. Page 49, 2nd paragraph - Why is more information needed on the Great Plains toad?

27. Page 53, Table 17 - The average annual equivalency factor should be identified in a footnote.

28. Page 54, 2nd paragraph - Do "damages" include the loss of local, State, and Federal taxes? This should be identified, if possible.

29. Page 56, Institutions Section - The various institutional roles existing in the basin should be identified at least in the overall report. This is important in the subbasin because of the lack of one institution that shows concern for the water resource activities over the entire subbasin. This may suggest that a Watershed District that covers the subbasin should be formed.

30. Page 60, 3rd paragraph - Where is "Breckenridge Lake?" It is not identified on any maps nor in any previous report discussions.

* 31. Page 61, 2nd paragraph - Add "Federal" between "appropriate" and "engineering."

32. Page 62 - Because this subbasin is one of the richest in environmental resources, specific environmental objectives may be appropriate to cover the protection and/or enhancement of wetlands and cultural resources, etc.

33. Page 65 - There should be more than an opportunity for implementation of nonstructural measures in the subbasin. Because no structural alternatives appear feasible, discussions on and evaluations of nonstructural alternatives should be included. The overall report should address and clarify this aspect which remains (particularly when structural alternatives lack feasibility) as one of the key elements in reducing flood damages in the subbasin. In urban areas, it is questioned whether floodplain zoning ordinances should be instituted because of the absence of overbank flooding. Because area communities sustain average annual flood damages, floodplain zoning ordinances should be a part of future efforts to reduce flood damages. Nonstructural alternatives should be considered given the information which is available and presented in this draft document.

34. Page 65, 2nd paragraph - This paragraph suggests that the potential for flood damage reduction using storage in wetland areas should be identified. Page 69 suggests that wetlands may play a substantial role in controlling run-off. These statements should be revised to be consistent.

35. Pages 68-69, Impact Assessment - An additional paragraph should be provided which assesses the relationship between the alternatives and the objectives.

* 36. Page 68, 2nd paragraph - The last sentence in this paragraph should be modified. At this time it cannot be determined whether a control structure and a channel improvement project would or would not have an effect on the cultural elements. This is because the Ottertail River subbasin has never been systematically surveyed for cultural resources.

* 37. Page 72, #13 - "Gaging" is misspelled.

* 38. Page 72 - Add #26 to include the consideration of forming a watershed district.